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Air Force Vehicle Fuel-Consumption Reporting
Premium Transportation: An Analysis of Air Force Usage
Isolated Mission
Readiness: A Commander's Responsibility

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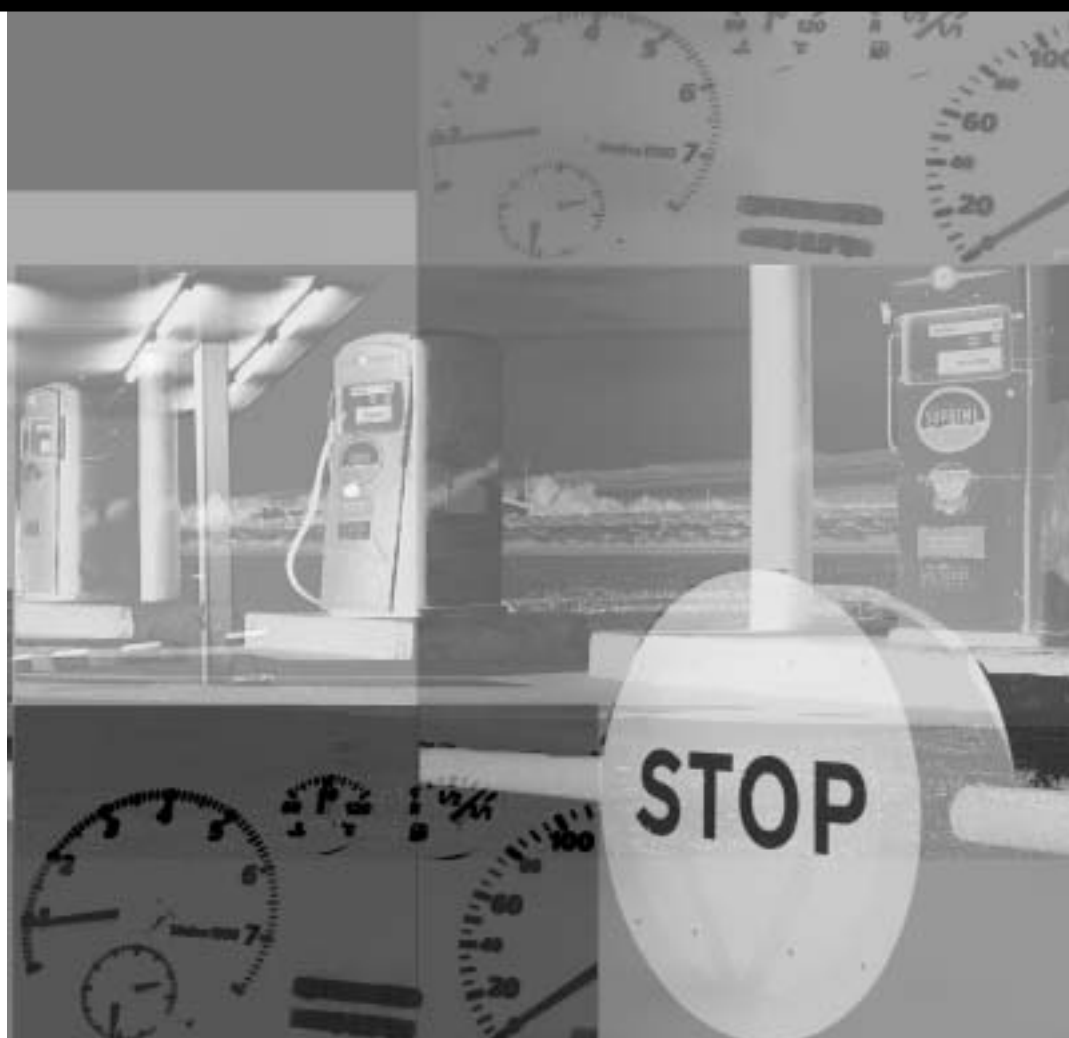
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Air Force Vehicle Fuel Consumption Reporting

Vehicle fuel-consumption reporting is nothing new; requirements to report fuel data are driven by public law. The Code of Federal Regulations, Title 41, requires each federal agency to develop accounting and reporting procedures to ensure accurate reporting of inventory, cost, and operating data for the management and control of motor vehicles. Fuel data make up one portion of the operating data for each vehicle. With the Energy Policy Act of 1992 (EPA) and Executive Order (EO) 13149, *Greening the Government Through Federal Fleet and Transportation Efficiency*, vehicle fuel-consumption reporting has become even more critical and complex. The Executive order requires a 20-percent reduction in vehicle petroleum consumption by fiscal year (FY) 2005, with FY99 data as the baseline. Also, alternative fuel should be used a majority of the time in bi-, flex-, and dual-fueled vehicles. With annual requirements for reporting vehicle fuel-consumption data to the Department of Energy (DoE) and the reporting complexities alternative fuels bring about, it is perceived that data collection systems are not accurately capturing the required types and amounts of fuel data. The Air Force Director of Logistics Readiness believed too many bulk-storage fuel tanks issue unmetered and unreported fuel to Air Force vehicles, the vehicle identification link (VIL) key does not offer the appropriate control over abuses of the system, and General Services Administration (GSA) reports are grossly inadequate in meeting reporting requirements.

The Air Force Logistics Management Agency (AFLMA) was asked to examine the perceived problems and issues and to



Federal agencies must develop accounting and reporting procedures to ensure accurate reporting of inventory, cost, and operating data for the management and control of motor vehicles.

ascertain if fuel consumption is captured accurately within the data systems used for reporting requirements and decision making. The following areas were of particular concern and provided a format for the research effort:

- The accuracy and adequacy of vehicle fuel-consumption data inputs to the:
 - Online Vehicle Interactive Management System (OLVIMS)

(Continued on page 30)

Premium Transportation

An Analysis of Air Force Usage

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Using premium transportation is a wise, economical decision for the Air Force; however, opportunities may exist for using alternatives to premium transportation in the CONUS.

Air Force supply policies are closely linked to the use of premium transportation. The logic for these policies is based on the classic tradeoff between inventory investment and transportation cost. In general, Air Force inventory policies are sensitive to transportation or pipeline times because inventory costs tend to be relatively high and transportation costs low. It is almost always more economical to invest in rapid transportation than to procure inventory.

In December 2001, the Strategic Distribution Management Initiative (SDMI) Board of Directors raised two issues concerning Air Force use of premium transportation: (1) not using or examining the use of SDMI transportation channels and (2) frequent use of premium transportation from air logistics centers.¹



It is important to note an apparent disconnect in the use of the terms *premium* and *fast* transportation. The Air Force supply community generally uses the term *premium* to indicate a desired velocity of movement (fast); however, the Air Force transportation community often interprets *premium* as a modal requirement (overnight air).

Regardless, the SDMI Board of Directors believes the Air Force uses premium transportation too often.

Three objectives underpin the examination of the issues raised by the SDMI Board of Directors:

- Identify policies driving the use of premium transportation.
- Validate shipping data presented by SDMI.
- Identify and evaluate transportation alternatives for overseas (Worldwide Express [WWX] versus SDMI) and continental United States (CONUS) shipments.

Analysis

Each of the supply policies driving the use of premium transportation was examined. Current Air Force policy calls for all reparable (XD) items to move via premium transportation. The expensive nature of reparable items and the need for rapid return of unserviceable assets to the depot led to this policy. While not all reparable shipments need to be moved via premium transportation, the lack of asset visibility and knowledge of a real-time asset position require they be moved via premium transportation.

During the analysis, a necessary activity was to bound the perceived problems associated with premium transportation use by estimating the money that could be saved if all Air Force-managed items were moved using a cheaper mode of transportation instead of using premium, commercial transportation.

The first step in establishing the bounds was to estimate the saving for individual packages. Given the time constraints levied for the analysis, a table of savings was constructed for a few packages (described by weight) moving on a selected route for each theater. The CONUS rates are not route-dependent; therefore, no set routes for the CONUS were included. The route used for the European theater was from CONUS to

Aviano Air Base, Italy. The route used for the Pacific theater was from CONUS to Kadena Air Base, Japan. The numbers in the CONUS column of Table 1 are the cost differences (savings) between FedEx 2-day and FedEx ground for each weight category. For the European Command and Pacific Command columns, the numbers are the differences between the average of the three WWX carrier rates and the sum of both FedEx ground-to-seaport-of-embarkation and Military Sealift Command final destination rates. The packages analyzed and the savings estimated are shown in Table 1.

The next step was to estimate the distribution of shipments by weight. RAND provided the Air Force Logistics Management Agency (AFLMA) data on Air Force shipments moved during fiscal year (FY) 2001, including shipment weight. To estimate the weight distribution of Air Force-managed items, all shipments not originating from an Air Force depot were filtered out. Every shipment was then put into one of the five weight categories shown in Table 1. Any shipment weighing from 0 and 10 pounds was put into the 10-pound category, from 10 to 20 pounds into the 20-pound category, and so on. The percentage of shipments for each category, by theater, is shown in Table 2.

Next, using readiness-based leveling data, the total number of shipments was determined for Air Force-managed items to the various theaters during FY01 (Table 3).

Finally, to estimate the upper bound on the total savings if all Air Force-managed items were shipped via routine vice premium, commercial transportation, the following assumptions were made:

- All items shown in Table 3 were moved using premium transportation. This caused an overstatement of transportation savings since commercial express carriers do not handle shipments heavier than 150 pounds.
- All the items were moved as individual shipments. This also overstated the transportation savings because the data often showed the number of items shipped was greater than one. Furthermore, commercial carriers charge less to ship one 50-pound package than fifty 1-pound packages.

The transportation savings for all shipments weighing from 0 to 10 pounds were approximated using the savings for a 10-pound shipment and so on. This overstated the transportation savings because very few shipments weighed exactly 10 pounds. The majority weighed less than 10 pounds, and the savings for a 5-pound shipment was less than for a 10-pound shipment.

The savings for all shipments weighing from 50 to 150 pounds were understated because each shipment in this category weighed more than 50 pounds and the cost for a 50-pound shipment was used.

Given these assumptions, to estimate an upper bound on transportation savings, the number of shipments moved in a theater was multiplied (Table 3) by the percentage of those shipments weighing a certain number of pounds (Table 2). That number was then multiplied by the savings per shipment for that type item (Table 1). The final results are shown in Table 4. For FY01, the maximum potential transportation savings for using routine transportation in lieu of premium transportation were \$17.5M.

Transportation velocity significantly impacts inventory requirements. As a result, any changes to the transportation system or transportation policies must take into account inventory costs and operational performance impacts. Air Force supply levels are very sensitive to transportation time. In fact, inventory levels are determined using an established transportation-time performance level maintained in the Standard Base Supply System (SBSS) database. This performance level is input into inventory computations in the form of order and ship time (O&ST). O&ST is the average time from requisition of an item until receipt of that item for each source of supply location. Clearly, a decision to change the transportation system that affects O&ST will have an effect on inventory levels and operational performance.

Consumables

For consumable items, the SBSS distinguishes items according to a desired transportation velocity. Items are flagged to indicate a desire for *fast* transportation or to indicate that *slow* transportation is acceptable. The terms

fast and *slow* convey a desired velocity. One could interpret *fast* to be Transportation Priority 1 or 2 and *slow* to be Transportation Priority 3. However, they are not designed to dictate a transportation mode. The modal decision is made by the transportation organization responsible for the shipment in response to the supply priority and required delivery date. The SBSS uses an algorithm to determine what level of inventory would be held using fast transportation and what level would be held using slow transportation. This algorithm makes an economic tradeoff between the transportation velocities. If it is economically beneficial to hold less inventory, then the system flags an item for fast transportation. Otherwise, the item is flagged for slow transportation. The flagging in SBSS was used to determine the difference in O&ST for items coded to move fast and those coded to move slow. The average worldwide fast O&ST for consumable items was 6 days faster than the average worldwide slow O&ST.

Reparables

For reparable items, the SBSS codes all items for fast transportation. Using information developed during the analysis of consumables, using slow transportation for all reparable items would result in a 6-day increase in O&ST. Raising reparable item O&ST by 6 days in the Aircraft Availability Model, the Air Force spares requirement computation model, resulted in an increase of \$96M to the spares requirement. Therefore, expending \$17M, at most, in fast transportation would eliminate the need for an additional \$96M in Air Force inventory. This conclusion makes no statement as to what mode of transportation is fast and what mode is slow. It only indicates the decision to use fast transportation seems to be a wise one.

Consumable items are also shipped via premium transportation. However, the analysis did not focus on these items since few consumable items are Air Force-managed. Also, a continuous economic analysis is used to determine when to use premium transportation for consumable items.

RAND Shipment Data

Data provided by RAND to the SDMI Board of Directors were reviewed. Figure 1 was developed by RAND, while Figures 2 through 7 were developed by

AFLMA using RAND data.

These data showed the Air Force used premium transportation for 75 percent of its shipments from air logistics centers. However, issues from air logistic centers represented only 3 percent of all shipments from Department of Defense (DoD) depots (Army, Navy, Air Force, and Defense Logistics Agency [DLA]) (Figure 1).

An examination of the movement of Air Force-managed items overseas during calendar year 2000 (CY00) by transportation control number (TCN) or total number of shipments showed that 90 percent of the TCNs moved via premium transportation while 9 percent moved via military airlift. Note that Commercial Air Lines of Communication, used mostly by the Army, moves palletized cargo via commercial aircraft. Military Air Lines of Communication is a similar system used primarily by the Army, except it uses military channel airlift instead of commercial aircraft (Figure 2).

By weight, 45 percent of all Air Force-managed items moved via premium transportation, while 55 percent were moved via military airlift (Figure 3).

The data for shipments of DLA-managed items to Air Force customers overseas during CY00 were also examined. By TCN or total number of shipments, 89 percent moved via premium transportation, while 11 percent moved via military airlift (Figure 4).

Weights	CONUS	EUCOM	PACOM
10 lbs	\$4.75	\$18.19	\$17.47
20 lbs	\$10.97	\$29.12	\$27.94
30 lbs	\$17.93	\$43.52	\$39.31
40 lbs	\$24.85	\$50.03	\$44.55
50 lbs	\$32.17	\$56.95	\$54.95

Table 1. Transportation Savings for Individual Shipments

Weights	CONUS %	EUCOM %	PACOM %
10 lbs	56	59	57
20 lbs	13	13	13
30 lbs	7	8	7
40 lbs	4	4	4
50 lbs	20	16	19

Table 2. Number of Air Force Shipments by Weight Category/Theater

	CONUS #	EUCOM #	PACOM #
Items Moved	996,500	77,142	99,132

Table 3. Number of Shipments Moved

Savings	CONUS	EUCOM	PACOM
10 lbs	\$2,671,388	\$830,742	\$983,152
20 lbs	\$1,472,625	\$289,908	\$378,241
30 lbs	\$1,253,320	\$258,088	\$307,798
40 lbs	\$1,009,647	\$154,728	\$180,010
50 lbs	\$6,096,640	\$711,699	\$959,000
Totals	\$12,503,620	\$ 2,245,165	\$2,808,201
Max Transportation Savings	\$17,556,986		

Table 4. Transportation Savings Upper Bound Standard Base Supply System Order and Ship Time

Examination of the data based on total weight showed 27 percent of the weight moved via premium transportation, while 73 percent moved via military airlift (Figure 5).

Overall, shipments of Air Force-managed items represented a very small portion of the items shipped by the Services and DLA. Also, even though the majority of overseas shipments of both Air Force-managed items and DLA-managed items for Air Force customers were moved via premium air, the majority of the weight moved via military airlift. The weight numbers are a better measure of what was shipped because rates are determined by weight, not by application of a flat rate per shipment.

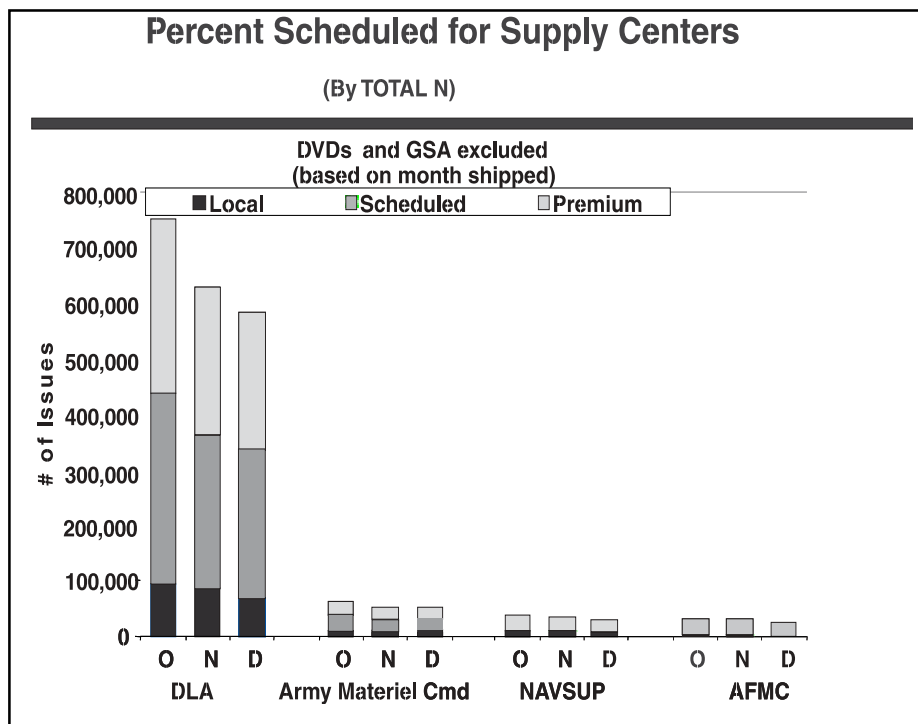


Figure 1. Revised RAND Chart—Movement by Number of Issues

WWX Versus SDMI

WWX was compared to the SDMI channel system to determine the better value. To do this, 892 WWX October 2001 shipments from air logistics centers to Ramstein and Spangdahlem Air Bases in Germany were examined. The analysis showed the volume of shipments was not conducive to movement via military airlift.

The average daily total weight shipped from an air logistics center to a base was 72.23 pounds. There was an average of 4.56 shipments per day from an air logistics center to a base.

From a cost perspective, WWX is a better choice than SDMI, except for shipments of 13 pounds or less or 2,200 pounds or more. The WWX per-pound rate was calculated by dividing the rates for each weight from 1 to 150 pounds (\$18,851.76) by the sum of the weights from 1 to 150 pounds (11,325 pounds), which equals \$1.66 per pound. The Air Mobility Command (AMC) rate (they charge by the pound) is the rate charged to SDMI customers for transportation from the shipment's origin to its destination, not just between the aerial

ports. It has a different per-pound rate for five different weight ranges: 0-439 pounds, 440-1,099 pounds, 1,100-2,199 pounds, 2,200-3,599 pounds, and 3,600 pounds or greater (Figure 6).

WWX carriers charge a rate for each weight from 1 to 150 pounds. The average of the rates between the three WWX carriers was compared to what AMC charges for shipments from 1 to 150 pounds. For shipments of 1 to 13 pounds, the AMC rates would be less expensive than the average of the three WWX carriers' rates. However, the average of the WWX carriers would be less expensive than AMC rates for shipments weighing 14-150 pounds. Overall, AMC would be less expensive than WWX if shipments were consolidated into loads of 2,200 pounds or greater (Figure 7).

The WWX process is more conducive to moving small shipments than is SDMI: simply package the shipment and give it to the carrier. SDMI requires consolidation into palletized loads, then movement to the aerial port of embarkation.

Overall, for WWX-eligible shipments (shipments weighing 150 pounds or less), the process and volume of shipments from air logistics centers to Ramstein and Spangdahlem favored using WWX over SDMI.

Concepts for the Future

Following discussions with RAND, they advocated the Air Force consider using alternative means of transportation *that would not degrade service or negatively impact readiness*. There are opportunities

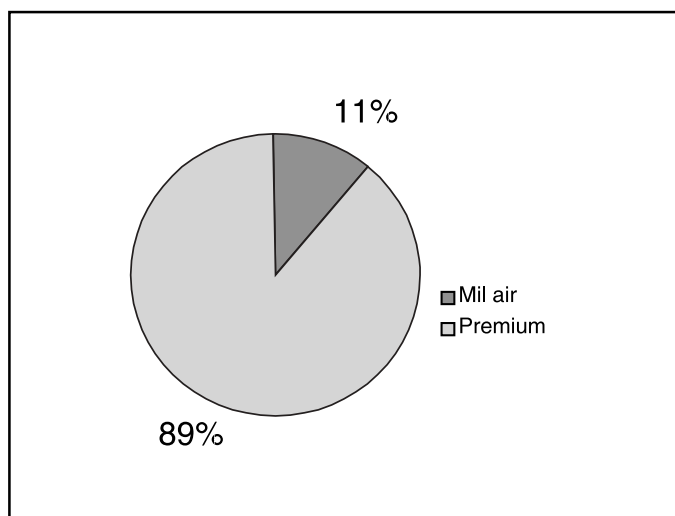


Figure 2. Overseas Movement of Air Force-Managed Items by TCN in CY00

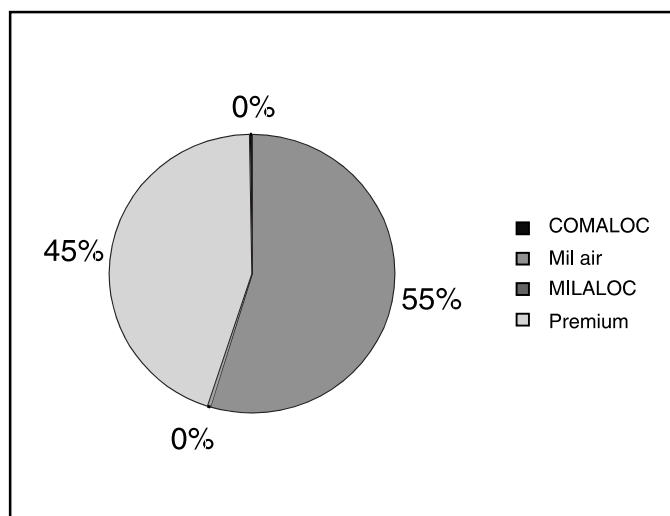


Figure 3. Overseas Movement of Air Force-Managed Items by Weight in CY00

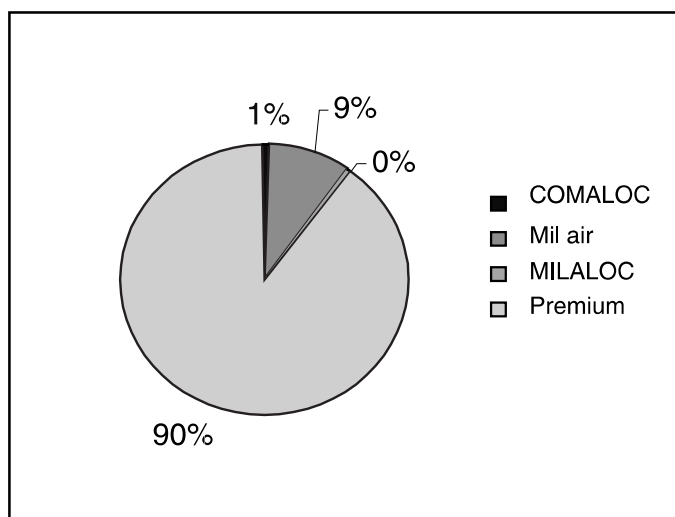


Figure 4. Overseas Movement of DLA-Managed Items to Air Force Customers by TCN in CY00

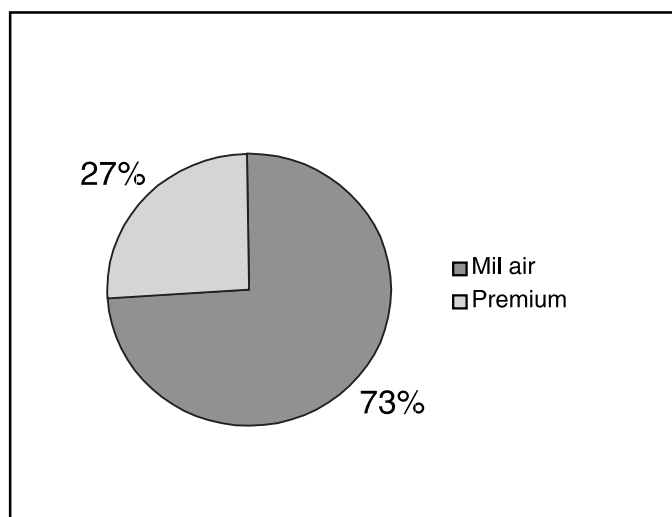


Figure 5. Overseas Movement of DLA-Managed Items to Air Force Customers by Weight in CY00

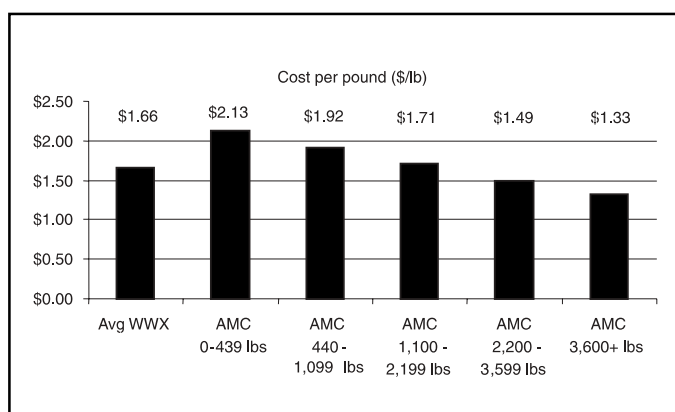


Figure 6. Cost per Pound for WWX and SDMI/AMC Shipments

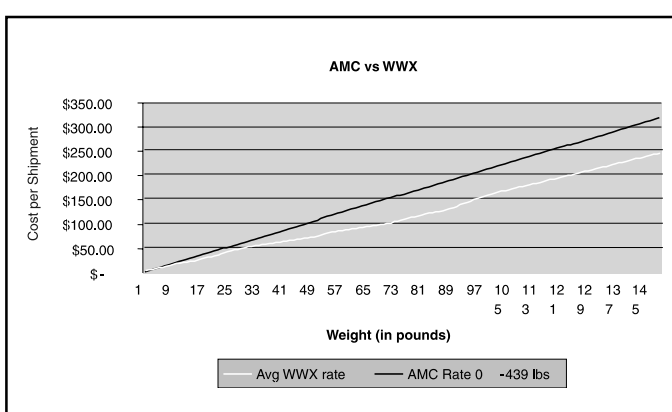


Figure 7. Cost per Shipment Between AMC 0-439 Pound Rate and Average of WWX Carriers' Rates for Shipments 0-150 Pounds

to evaluate alternative means of transportation (for example, scheduled truck routes) within the CONUS. Also, RAND suggested that the Air Force reposition some assets to DLA depots where it makes the best sense to do so. The Air Force Directorate of Logistics Readiness and AFLMA are considering several alternatives to improve the customer and supplier relationship with DLA. The Air Force Stockage Policy Working Group is currently considering several alternatives, which include regional stockage policies and repositioning of assets.

Conclusions

Using premium transportation is still a wise, economical decision for the Air

Force. For WWX-eligible shipments, the Air Force should continue to use WWX to and from overseas locations.

Opportunities, such as scheduled truck routes, may exist for using alternatives to premium transportation in the CONUS and should be assessed.

Recommendations

The Air Force should continue to be engaged with SDMI. AFLMA should be tasked to study SDMI and RAND proposals for applicability and benefit to the Air Force by evaluating alternatives to premium transportation in the CONUS and evaluating repositioning wholesale stock where it makes sense to do so.

Notes

1. SDMI was established to better streamline DoD distribution and logistics and is a joint venture of the US Transportation Command and DLA.

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JL★

Basic research is what I am doing when I don't know what I am doing.

—Wernher von Braun

While carry-along, planned-rendezvous, and preposition strategies are usually envisioned, their advantages seem to weaken when the supply chain is lengthy and risky, as is the case in a Mars mission.

Isolated Mission

Manufacturing Spare Parts Through Rapid Prototyping

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Introduction

Maintaining the performance of logistically isolated systems yields serious support difficulties. In the perspective of a human mission to Mars, it is known that the ability to maintain systems and, more specifically, spare parts management is a key issue. Usual solutions consider improvements in reliability and fault tolerance, storage of carefully selected parts, potential resupply missions, or a combination of these strategies.

In this article, a different approach is proposed. From the observation of an analogy between physiology and parts manufacture, the use of rapid-prototyping and manufacturing techniques to replace, on site, a failed element with one intended for temporary repairs is considered. The system can then be restored to an acceptable level of performance so as to continue the mission or wait for a more permanent repair. Although the concept offers interesting possibilities, some questions must be raised regarding its technical feasibility, as well as reliability and safety impacts on the mission. The article is organized as follows: the first part briefly describes supply support methods and highlights their characteristics; the second part proposes and discusses the rapid spares manufacturing concept; the contribution of rapid prototyping techniques is evaluated in the third part and illustrated as an example; and the last part indicates research perspectives linked with *in situ* resources utilization, as well as the qualification process for such spares.

Supply Chains of Distant Exploration Missions

First, *logistically isolated* must be defined. A system is logistically isolated whenever external conditions govern the supply operations. Several systems answer to such a definition: arctic missions; oil platforms; and of course, manned space missions. Logistics support of human space missions is about providing the resources needed to support the crew, systems, and scientific users throughout the mission.¹ Crew support consists of items required for direct support of the persons inside the orbital vehicle or station, such as consumables, food, clothing, accommodations, and personal items. User support includes items needed to support requirements for scientific research and experimentation, such as tools and refrigerated containers. Systems support includes mainly spares, repair parts, and consumables, as well as tools and documentation. In the case of the Freedom Space Station (which should not be very different from the International Space Station), it was estimated that, for a typical resupply mission, the two most significant items were science items (33 percent) and maintenance items (27 percent); then came crew accommodations (18 percent), propellant (14 percent), and cryogenics (8 percent). A reasonable rule of thumb for estimating the quantity of spares needed per year of operations seems to be 5 percent of dry mass per year.² The recent National Aeronautics and Space Administration (NASA) Mars Mission-scenario estimates for spares are very similar (6 percent).³ Although maintenance problems for Mars missions seem to be focused on crew time and systems health monitoring, it would be more realistic to consider the possibility of a failure. In such a case, the ability to repair will be a determinant. As J. L. Chretien, one of the French astronauts, said concerning Mars missions, "Why do you want

me to cross a desert in a car I know I cannot repair?"⁴ It is known that spares are the most visible part of logistics support problems.⁵ Going with the wrong spares or with the wrong number of spares can seriously impact both mission performance and budget. It is obvious that spare parts will also take volume and mass off the mission budget. If we want to have a successful Mars mission, such issues need to be addressed early.

Establishing a supply support concept is difficult because it involves compromise among many variables. However, experience with similar systems can be particularly useful in defining support and spares parameters. Two key questions must be asked: How to select the elements to spare? In which quantity? Two main rules emerge regarding spares: first, plan what is foreseeable, and second, prepare for the unexpected. The main issue seems to focus on the length of acceptable functional degradation. Some items are obvious spares candidates; for example, elements with a limited useful life (filters), but what about the others? The truth is that we would like to either bring a bit of everything or have no need for spares at all. Since it is not feasible to go without spares, several strategies have been established to provide such resources. Note that these strategies consider resources in general, not maintenance resources such as spares (Table 1).

While carry-along, planned-rendezvous, and preposition strategies are usually envisioned, their advantages seem to weaken when the supply chain is lengthy and risky, as is the case in a Mars mission. Facing unforeseen situations seems very difficult with only these strategies. While carry-along, planned-rendezvous, and preposition strategies are usually envisioned, their advantages seem to weaken when the supply chain is lengthy and risky, as is the case in a Mars mission. It seems logical and reasonable to use live-off-the-land strategies for maintenance and provide the crew with the means to repair virtually anything that needs to be repaired. Most of the time, failure does not mean the end of the mission, rather a degraded state. What would be needed then are the means to either repair the equipment or keep it in an acceptable status or condition until it can be repaired or while it is being repaired. In some respect, only one sophisticated system is able to do this; namely, the human body.

Supply Chain Analogy

The human body is able to sustain a wide variety of failures for various durations. Simplifying the real physiological process, one can say that the repair process is composed of two distinct parts. To understand this, one can take the example provided by the rupture of a small blood vessel. The first part of the process consists in trying to maintain the function (circulation of blood).

Strategy	Description
Carry-along	All supplies required for the mission duration are brought with the spacecraft.
Planned-rendezvous	Supplies are sent to the mission site before/after the crew arrives.
Preposition	Resources are stored for a given period of time then resupplied.
Live off-the-land	Supplies are produced on site, mainly using local resources.

Table 1. Supply Strategies to Provide the Mission Resources

Vasoconstriction of the vessel and fall of pressure slow the blood flux, and immediately, a seal is started. In the second part, when the situation is stable, the body starts building new skin.⁶ One can notice several interesting points concerning this repair process. First, the concept of palliative repairs seems to be crucial since it allows the system to run while waiting for permanent repair elements. It strongly suggests that what is important is to maintain the function, even degraded, but not necessarily the elements. It also suggests that, under resource constraints, it seems logical to provide enough time for the repair process to take place. Second, it is striking to see that there are no stored spare parts but a knowledge of how to duplicate the failed part, skin cells in the human analogy. This knowledge is contained in the genetic materials and encompasses the parts information, as well as the manufacturing process. The body adapts itself to gather enough energy to perform the repair process. Unfortunately, the damage is sometimes too extreme to be fixed by this process.

We have tried to make analogies between these two observations and the repair process of technical systems or equipment. Though one could think of nanomachines that perform precisely what the body achieves, this technology is not ready yet, and we chose to take a look at already available technologies. The human body uses instructions contained in genetic materials, as well as in internal resources (cells, energy) to build the needed elements (Figure 1).

The analogy with computer-aided manufacturing (CAM) seems clear. In such a methodology, one uses data in the form of computer-aided drawings (CAD) and instructions for the numerical machining tools, as well as other resources such as machines, energy, and raw materials (Figure 2).

One might then be inspired by this analogy to do in a technical environment what Nature is able to do for a biological system. From this perspective, it is possible to imagine replacing a failed element with a palliative one manufactured on demand to provide time to the system that could be used to finish the mission, wait for an incoming resupply cargo, or manufacture a permanent repair part. What we then imagined is to be able to manufacture, on demand and on site, the needed parts, using CAD/CAM files and a pool of raw materials.

It is not realistic, however, for operational or technological reasons, to believe all elements are rapid spares candidates. A list of potential elements has to be established. Although this might change on Mars, mechanical parts are not the ones that fail most often. However, it is the mechanical structure of an element that usually has the main share of the mass. Although mechanical parts can impair the mission when they fail, they are not always stored as spare parts. A broken fender on the Apollo XVII Moon Rover had dust showering crew and equipment but was repaired with a spare lunar map and clamps.⁷

While we consider mainly mechanical elements in this article, it might be possible to go further than just manufacturing the structure when considering programmable chips, hardware-independent design techniques (very high-speed integrated circuit hardware description language), standardization, or evolvable hardware.⁸ Note that very recent research in France made plastic transistors possible.⁹

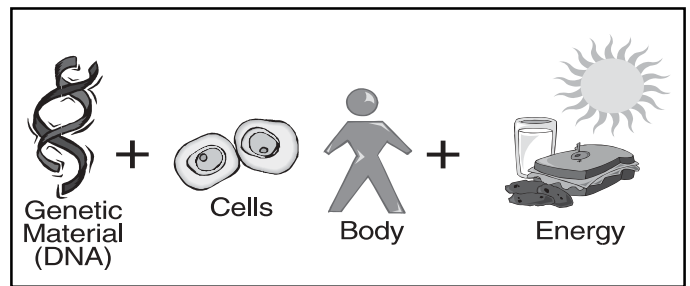


Figure 1. Simplified Skin Repair Process

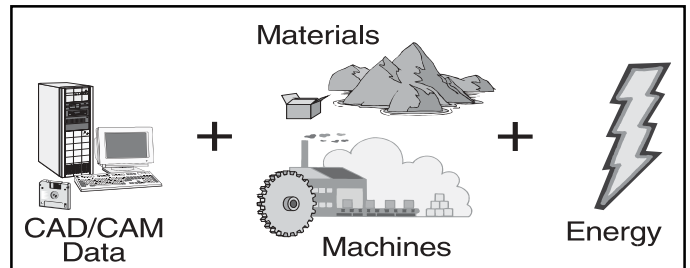


Figure 2. Simplified Manufacturing Process for an Element

Achieving a Workable Concept

Rapid prototyping and rapid manufacturing techniques allow parts manufacture with a rich and complex variety of shapes. Although not used for their original purpose, they might be a good solution to manufacture swiftly any needed spare parts. As is explicit in its name, rapid prototyping means manufacturing of models and prototypes and qualifies the process to reconstitute physically 3D objects described by their CAD data, without tooling, and in a fraction of the time required by classical manufacturing techniques.¹⁰ Manufacturing such objects is made through a progressive adding of materials that is the opposite of rapid manufacturing techniques based on removing materials. Time required to build the parts implies these methods are dedicated to very small series, even single units. It is important to note that in the case of rapid prototyping there is no waste of raw materials, while with rapid manufacturing, there is a production of chippings, which are not usable afterwards. The energy required for the two methods is also very different. We, therefore, chose to focus on this family of technologies. The rapid prototyping process is based on a digital description of the object in slices. Starting from the 3D surface or solid model, parallel sections are computed perpendicular to the machining direction. The spacing between slices corresponds to the thickness of material creation. The 2D descriptions provide the contours and the means to distinguish between internal and external areas. The adding of material is done on the previous slice via solidification of a resin or a thermomelting material, via agglomeration of powders or gluing of sheets of materials. It is possible either to construct the objects point by point (laser-based systems) or one slice at a time (mask and lamp-based systems). The majority of the processes rely on a change of the state of the material (liquid to solid). Typically, a monomer resin is used: starting with a tank full of resin, the object is built layer upon layer to obtain the element at the end of the process. The largest parts obtained so

(Continued on page 44)

The differences between a ready force and an ill-prepared one are the confidence, attitude, decisiveness, and endurance of the people.

Overview

Background

The purpose of the military, when not engaged in contingency operations, is to prepare for its wartime mission. This article focuses on a commander's role in facilitating the process of ensuring deployable squadron members are in a state of readiness. "As a commander or supervisor, you assume full responsibility for the accomplishment of your unit's mission."¹ Considerable research and analysis has been dedicated to the materiel and equipment aspects of readiness; this article emphasizes measures to prepare troops to achieve a mission-capable, readiness posture. The conclusion is a set of readiness-enabling factors and supporting comments to serve as a guide for commanders of mobility squadrons as they assume command and start defining priorities.

Major Douglas A. Furst, USAF

Readiness

A Commander's Responsibility



Air Force basic doctrine begins with this fundamental truth: “The overriding objective of any military force is to *be prepared* to conduct combat operations in support of national political objectives—to conduct the nation’s wars.”² The men and women who work for the military services direct their efforts, resources, and energies to accomplish this by training, organizing, and equipping forces to produce mission capabilities. These capabilities include the equipment, information, skills, supplies, strategies, tactics, plans, agreements, and knowledge that contribute to a squadron’s designed operating capability (DOC).³ This process of merging military technologies, resources, and troops into an able national instrument of power is the *process of developing readiness*. From a major command (MAJCOM) perspective, the Air Mobility Command emphasizes the readiness aspect of its mission as:

Today, more than ever, our nation needs rapid, flexible, and responsive air mobility. America’s Global Reach promotes stability in regions by keeping America’s capability and character highly visible. Joint military exercises display military capabilities and bolster U.S. ties with allies.

Humanitarian missions strengthen relations with recipient nations and show the watching world America’s compassion. Projecting influence can be an effective deterrent to regional conflicts. Should deterrence fail, Global Reach allows for the rapid and decisive deployment of combat power.⁴

Figure 1 outlines the preparation process for executing America’s military instrument of power.

This conceptual process traces the purpose of military preparedness as defined in the Promotion Fitness Examination under the general functions of the military departments.⁵ Comparing the activities necessary to prepare forces for an appropriate state of readiness with what is actually *done* on a day-to-day basis, squadrons very easily can lose their readiness focus, if improperly led, by pursuing nonmission-essential objectives. Troops at the squadron level perform activities that support the priorities and focus of their commander. In oaths of office, officers swear to perform the duties they are about to enter,⁶ and enlisted members swear to obey the orders of the officers appointed over them.⁷ General W. L. Creech, former Tactical Air Command commander, said, “Leaders lead by example and set the tone.”⁸ Following this logic, if the commander fails to ensure the unit stands ready with adequate mobility and field survival skills, training, and experience, the troops deployed from that unit will risk facing contingency challenges without the adequate confidence, knowledge, and capability to succeed.

Commanders need a plan, a tactical set of readiness indicators pointed toward achieving an overall strategic state of readiness. This concept is the foundation for the strategic planning process: analyzing the mission, envisioning the future, assessing capabilities, performing a gap analysis, developing strategic goals, and formulating a plan. This article provides a series of readiness concepts developed by consolidating mobility-readiness-enabling factors. These readiness enablers provide new commanders an *expert* perspective for preparing an organization for contingency operations. They will help commanders with the first strategic planning step—analyzing the mission and assessing capabilities.⁹

Some officers learn to command effectively from extensive personal experience and deploying to challenging contingency operations while others build a good perspective from close

mentoring. This article combines the benefits of both experience-building paths by pulling the expertise from many senior officers and noncommissioned officers (NCO) who have *been there, done that*. It will help squadron commanders at the wing level determine the most important decisions in establishing the correct readiness focus.

A readiness posture determines how well an organization responds to a phone call at 1730 Friday afternoon from a MAJCOM execution cell requesting a *22-man package to deploy on verbal orders, within a few hours, to operate in field conditions in a cold and wet climate, at a classified location with a moderate threat for an undetermined duration*. Does your squadron adequately prepare your troops for this challenge?

How We Prepare

The challenging nature of this scenario reflects the unpredictable and volatile world we live in, as well as the nature of our job. Further, consider what occurs at a typical airlift wing on any given day. Based on personal experiences from the last 14 years, there would probably be activity involving many ongoing processes.

Home-station troops perform specialty skills such as transporting cargo and passengers on regular schedules between predefined channel locations, maintaining and protecting aircraft, importing and exporting supplies, shipping equipment and household goods, and flying training sorties to maintain aircrew proficiency. They perform not only their jobs but also additional duties—marching in the wing honor guard; serving on evaluation boards; performing details for the wing, squadron, or flight; attending wing and squadron meetings; and participating in public ceremonies. These activities are in addition to studying for the annual specialty skills knowledge testing, attending college classes at night, and taking professional military education courses. Very little of this activity prepares an individual to *think mobility* or maintain readiness.

Deployed troops perform specialty skills, the vast majority of the time living in hotels with *minimal risk* of criminal or terrorist threats. This experience fails to teach contingency situational awareness or the ability to survive and operate and communicates a false sense of security, which leads to complacency. Complacency leads to vulnerability in an actual contingency.

Wartime skills training is the least time-and-effort-consuming, as troops accomplish annual refresher training in chemical warfare, self-aid/buddy care, and weapons

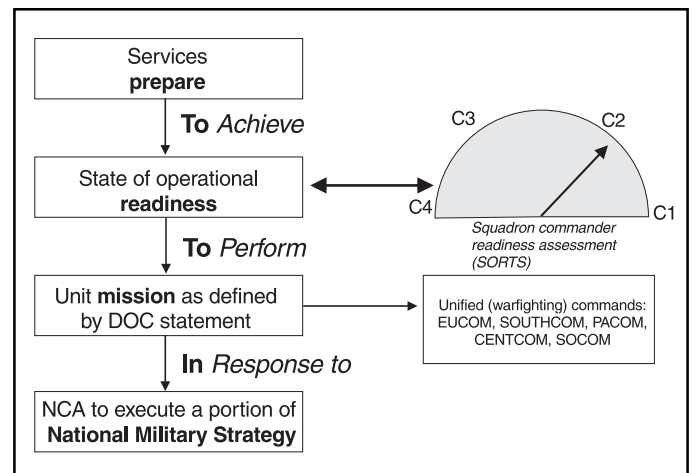


Figure 1. Purpose of Preparing

(M - 1 6 / M - 9) a n d infrequently deploy for a few days in support of an exercise.

From a generic perspective, there is concern that preparedness for deployed operations does not have much priority in day-to-day life and may not meet the necessary readiness level. Without an external impetus to generate training scenarios, human nature tends to lead to readiness entropy at the minimal requirement. General Ronald R. Fogleman, former Air Force Chief of Staff, stated, as a commander, “You are responsible for everything your unit does.”¹⁰ The reason readiness degrades is twofold: it is a proficiency level with a shelf life requiring refresher training and exercising to maintain currency,¹¹ and it incurs a cost in both effort and budget. The total resources available to pay these costs are finite and compete with many conflicting priorities. Because readiness is perishable, it is necessary to train—ideally at the time an individual loses the abilities to perform the skills but not constantly so as to expend all the time, money, and energy of a squadron.

Why We Prepare

The point to addressing mission readiness in relation to the time spent in wartime-skills training is that—without the challenge and regular exposure to wartime situations, experiences, and environments—troops risk losing their perspective on what it takes to quickly deploy, survive, and endure high-tempo operations in the field; in other words, *getting soft*. Tactical Air Command Manual 2-1 points out:

The pace of modern high-intensity war will not allow time to polish skills, develop new procedures, new techniques, and new organizational structures as the crisis develops or after hostilities begin. Hence, training for aircrews, training for the battle staffs, and training for our maintenance people [and all other troops deployed in the contingency environment] must be as realistic as possible.¹²

This attitude is an intangible concept yet critical to mission effectiveness. Future readiness needs are clearly emphasized in the following statement from Air University:

These will be fight-anywhere, fight-anytime wars, where *anywhere* and *anytime* will largely be defined by the enemy. The battlespace will be characterized by sudden and awesome lethality. The outcome will be determined in large part by the readiness of US forces to engage the enemy.¹³

Losing sight of readiness distracts and distorts an individual’s perspective of why one is wearing the uniform and degrades the ability to identify and address threat activity. As a result, the individual will fail to react automatically with the skills needed to rapidly mobilize; establish operations in an austere environment; and sustain a safe, effective, and reliable capability to fight. The cost of not being ready could be catastrophic.

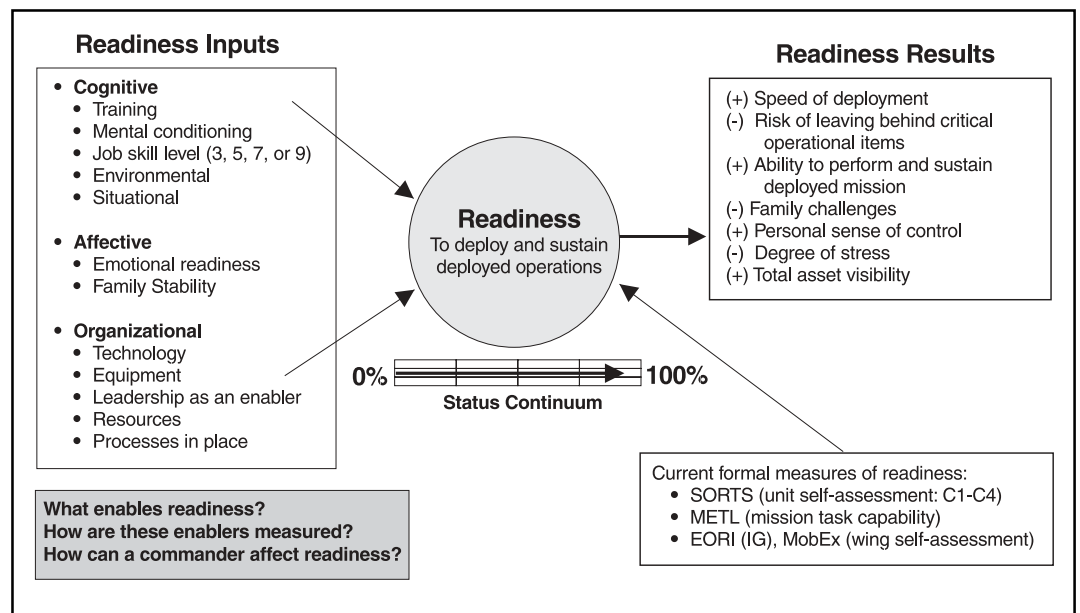


Figure 2. The Readiness Process

The United States may be faced with an adversary who seeks to offset advantages the United States has by using asymmetric means and threatening the use of chemical or biological weapons, information attacks, terrorism, urban warfare, or anti-access strategies. As a result, America must quickly seize the initiative from the aggressor. *Military capability that is vulnerable to preset time lines risks attack of those time lines. Delay in decisively and quickly halting an enemy may force a difficult and costly campaign to recover lost territory.*¹⁴

This issue of personnel readiness warrants study and focus. The concept is complex and involves many factors: technical job knowledge, an acute understanding of how to operate in the contingency environment, and an ability to give and receive direction and orders. Readiness also extends beyond these factors to encompass less direct aspects such as maintaining physical fitness and ensuring personal family affairs are in order. Figure 2 captures the relationships between the concepts associated with building readiness and the outputs resulting from it. It is a tool to visualize what readiness does in relation to the troops, the commander, and the mission. The inputs on the left characterize the actions taken to prepare for readiness.¹⁵ The feedback process in the lower right corner identifies the assessment of readiness. Finally, the righthand block captures the impact of readiness. The (+) and (-) can be read in the following terms, “As the level of readiness *increases*, there is a corresponding positive (in the case of [+]) correlation with the speed of deployment.”

Cost of Failure to Prepare

Failure to stand ready results in a breakdown of emotional and physical performance, which ultimately reduces mission capability. To prevent history from repeating itself, all airmen, soldiers, and sailors should understand why 2,400 men and women died on 7 December 1941 at Pearl Harbor when the radar technician saw and reported the warning of a potentially massive attack: “a larger number of planes than he had seen before on his [radar] scope.”¹⁶ Lieutenant Kermit Tyler, upon receiving this message in the Fighter Information Center, failed to respond in any way, to inquire further, or report the observation up the chain

of command and took no defensive actions. Leadership failed to ensure an appropriate level of readiness.

Troops do not achieve readiness by performing day-to-day job skills and attending annual refresher training. More specifically, if they are focused year after year on peacetime operations and steady-state environments within a wing, their attention will probably focus on minimizing costs by optimizing *efficiency*. On the other hand, the focus in war is *effectiveness*: achieving the mission while minimizing the loss of people or equipment.¹⁷ The attitudes, goals, and perspectives of efficiency and effectiveness are different; both efforts are important but must be understood in the proper perspective. Priority decisions between the two objectives require different preparation, focus, and training.

Efficiency is necessary given the realities of the post-Cold War environment that is characterized by the American public's desire to benefit from a *peace dividend*, which translates to reduced military spending. The National Campaign for the Peace Dividend resolved:

We, the People, believe that the United States of America should remain the world's strongest nation, but we find current levels of military spending to be unnecessary, unwarranted, and excessive. We direct our representatives in the Federal government to begin an orderly long-term program to substantially reduce military spending to levels more in keeping with the close of the Cold War and with our national economic capabilities.¹⁸

Yet, effectiveness to conduct military operations at all times is critical to maintaining the national military objective of a credible deterrence. Effectiveness is the ability to perform the mobility readiness challenge, but it becomes vulnerable when overtasked. Figure 3 clearly conveys the concept of overtasking as a result of increased workload with fewer people.

A proper balance between readiness and operations tempo (OPSTEMPO) does not occur naturally but requires deliberate planning, readiness proficiency monitoring, and responsive training. Commanders determine when to perform in-house training, push for wing exercises, and request time to *stand down* the forces. This balance of OPSTEMPO, real-world mission needs, and readiness levels is a critical equilibrium to consider.²⁰ It cannot result from a preprogrammed checklist because every command situation is different. Therefore, a set of guidelines or commander heuristics may prove helpful in making these tradeoff decisions to maintain balance.

Research Question

Research for this article centered on the commander's role and perspective on readiness and the resulting impact of a leader's actions on the unit's degree of effectiveness in performing its wartime mission. This equates to the following research question: *How does a commander most effectively measure, track, interpret, and affect the personnel readiness of a squadron?* The key words in this question are *measure, track, interpret, and affect*. Answering this question will provide useful insight to new commanders when preparing their units for mobility readiness.

Research Objectives

To adequately answer the question, the research built on itself through four distinct phases.

- An operational *definition* of readiness from literature, regulations, doctrine, and experts was developed.

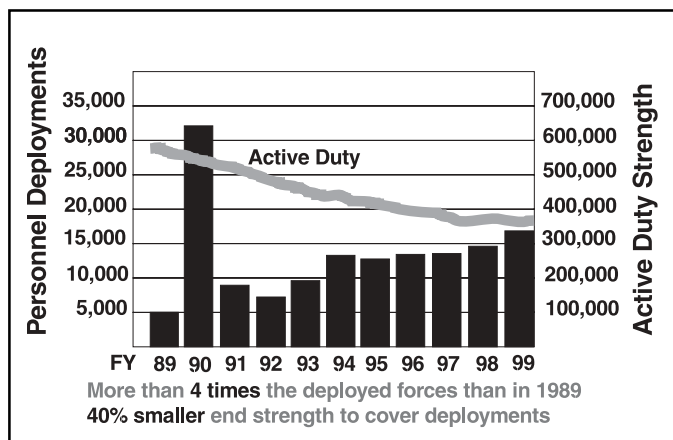


Figure 3. Doing More with Less¹⁹

- Current readiness-evaluation processes from the Status of Resources and Training System (SORTS), Mission Essential Task List (METL), and Expeditionary Operational Readiness Inspection (EORI) are aggregated, and deficiencies in effectively providing timely pertinent readiness feedback were identified.
- A commander's readiness tool, in the form of a short top-level guide—*Mobility Personnel Readiness—Enabling Factors: a Comprehensive Guide for Commander*—was prepared.
- Results were submitted to the Air Mobility Command (AMC) to augment its new commander training program during the AMC Inspector General's readiness blocks of instruction.

Investigative Questions

Personnel readiness is an intangible concept that does not have concrete, black-and-white characteristics. This research broke down the readiness concept into further detail by attempting to answer investigative questions.

- What is readiness?
- What methods are useful to measure readiness?
- What factors enable readiness?

Scope and Assumptions

Not all active-duty, wing-level squadrons mimic the activities outlined in the day-to-day description. Many squadrons, such as the air mobility operations groups and United States Air Forces in Europe combat readiness groups, perform deployment readiness preparation actions daily while in garrison; this article is not written for them. Similarly, flying units deploy as their primary core competency and rarely endure operating and living in field conditions for long periods.²¹ This research is scoped primarily to focus on support squadrons that deploy infrequently.

Literature Review

Introduction

Most literature on military readiness centers around weapon systems' mission-capable rates, based on spare parts, repair supply levels, and available spare assemblies such as engines, radar systems, and line-replaceable units. This partial focus is a funding justification process that requires considerable analysis in Washington.²² The people side of readiness is a concept mostly discussed in aggregate terms of recruiting rates, career-

field manning strengths, and top-level training statistics on how many have achieved a 5, 7, or 9 skill level in their specialty. Very few articles specifically address the critical components of personnel readiness, such as how an organization develops attributes in deployable members that enable them to perform the mission in a contingency environment.²³

Define Readiness

Readiness is a concept with different meanings for the different Services, MAJCOMs, career fields, and ranks. The most common definition focuses attention on the facets captured in SORTS. The following three definitions converge on similar aspects:

- **United States Code, Title 10.** “The Military Departments are responsible to recruit, organize, supply, equip, train, service, mobilize, demobilize, administer, maintain, and provide facilities for *wartime readiness*.” Readiness could then be considered the result of doing the above activities.²⁴
- **Readiness.** The ability of forces, units, weapon systems, or equipment to deliver their designated outputs. This includes the ability to deploy and employ without unacceptable delay.²⁵
- **Ready.** a: *Prepared mentally or physically for some experience or action*; b: Prepared for immediate use; willingly disposed. Readiness is the noun form of ready.²⁶

The problem with these perceptions of readiness is that, for people receiving a short-notice deployment order, their perspective of readiness is far more detailed than the first two definitions. Because our systems are designed and proven to get to the fight, readiness does not seem too complex, but it is the capability to perform under austere conditions and the ability to sustain deployed operations that truly embody the effect of readiness. Therefore, these definitions are a good start, but they require a more comprehensive explanation.

Perspectives on Readiness

All uniformed members with a wartime specialty skill should have a *mobility* attitude and an expectation of performing their mission in a contingency scenario. After Desert Shield/Storm, Army Lieutenant Colonel Stevenson made the following statement about deployability:

Perhaps the lessons regarding deployability can best be summed up by noting that deployability is a basic requirement of soldiering, much like being able to qualify with one's individual weapon or being able to don a protective mask within the required time. Commanders at all levels would do well to insist that no soldier who is permanently nondeployable be permitted to remain on active duty.²⁷

As Colonel Stevenson implied, deployability and the ability to perform military operations in field conditions are a military core competency built on skills. To best understand readiness, it is helpful to explore challenges and experience from historical major contingencies.

Logistics Lessons Learned from Desert Shield/Desert Storm. The Joint Universal Lessons Learned System (JULLS) is a tremendous source of information on the impact of problems with personnel readiness.²⁸ JULLS confirms many of the concerns mentioned previously about troops deploying without medical and on-the-job training records, training, equipment, or sufficient preparation. Many of these problems were attributed

to exercising artificially, which failed to adequately test capabilities or build the comprehensive set of skills needed to succeed without incurring unnecessary costs. “Mobility simulations did not reflect actual mobility movements. People were unprepared to mobilize. Equipment was shorted. Bags were not ready. Wills and powers of attorney changed.” Additionally, JULLS highlighted the significant problems encountered with personnel who were not filling a mobility position but deployed anyway; these people experienced the most emotional and performance problems as a result of inadequate preparation. JULLS also identified the positive value of deploying units as a unified team as opposed to the common practice of piecemealing units together.

Desert Storm Readiness Example. The Army's 141st Signal Battalion was a poignant example of how readiness factors affect mission effectiveness.²⁹ The unit stood down its readiness posture in an equipment upgrade transition. Old equipment was sealed and turned in, no longer serviceable or available. The new system had not arrived; therefore, the unit was not mentally or operationally prepared to perform its wartime mission. They deployed to Operation Desert Shield on 24 December 1989, requiring a significant spike in last-minute activity to retrieve all the old equipment, pack all available spare parts, and prepare a group of people who had considered this transition time as nondeployable. This example emphasizes the importance of C-rating accuracy when reporting a unit's status.

Also related to personnel readiness was exercise experience. The unit was prepared by weeklong exercises, but these short exercises did not prepare them for the desert. Short-term child care plans and an inordinately high number of pregnancies (plus soldiers who turned up pregnant in theater) indicate a lack of emotional preparedness and personal understanding of what it means to be a member of the military. Commanders can have an impact by ensuring realistic training and propagating a mobility mindset where all activities in peacetime track with a connection to the contingency mission.

Commanders may not eliminate all situations like the ones experienced by the 141st, but they can directly mitigate the problems that reduce the military's ability to perform its mission.

Relation of Readiness to Leadership. For years, senior leaders have emphasized readiness as the top priority and used it to justify funding new equipment and spare parts. Air Force Chief of Staff General Michael Ryan discussed his fiscal year 2000 priorities:

Our Air Force men and women and their commanders have done great work keeping control of readiness declines despite heavy tasking and tough fiscal constraints. Nonetheless, the mission-capable rates have declined. The . . . three readiness priorities are people, equipment, and the training to employ them.³⁰

He said if he “could put a bubble around this that enables it all to happen, it would be leadership.” He goes on to say that the essential component of readiness is “the confidence in their capabilities to do what we ask them to do, and that involves equipment, training, and leadership.”³¹ The readiness challenge is further exacerbated with increased OPSTEMPO. The force today is manned at a level that is 33 percent below what it was 10 years ago, and the relative deployment workload exceeds 400 percent of what it was. This OPSTEMPO affects all personnel, deployed and at home station, as the base unit continues its

mission with fewer people. After enduring this environment, all ranks and career fields respond with high numbers leaving the service at the earliest possible opportunity. This emphasizes the importance of protecting *leave* and *recovery* periods after deployments as justification for dropping readiness assessments when needed to give troops a chance to achieve some form of control and balance.³²

In August 2000, the *Washington Times* reported comments on military readiness: "Equipment wore out. Spare parts dried up. And personnel, weary of months overseas, quit." This report discussed recruiting and retention issues as results of low readiness situations and discussed possible causes. It described the 1980s as a time of the finest military ever with unmatched esprit de corps as a result of strong military support and growth. It emphasized the need for adequate military funding and the importance of communicating the value of the troops to the nation. Finally, it discussed the Marine Corps and why it was the only service achieving its recruiting goals. It again came down to leadership and motivation. The Marines promised competence, status, and team integrity. These values and status attract recruits.³³ Leaders at all levels can learn from the Marines rather than focusing on how much they can give in financial compensation. The findings of this research support this position.

Importance of Realistic Combat Training. A 1995 report on combat training emphasized the need for training forces how they will fight. It described this training "not as a luxury, but a necessity," justifying continuation of the 50+ major joint and combined exercises around the globe each year despite their high cost. The focus of these exercises is to "arm our people with experiences that emulate actual combat in its most demanding phases." The report cautioned our leaders to avoid diverting money from readiness to contingency operations late in the fiscal year to balance budgets; this practice prevents new personnel from building experiential knowledge that has no equal in the classroom. Direct experience does translate to action at bare-base deployment locations that require standing up an operational airfield and overcoming interservice and host-nation challenges.³⁴

Family and Readiness. In 1997, the Washington Consulting Group report on the influence of family factors on individual readiness, retention, and job commitment determined that certain demographically grouped servicemen had significantly more difficulty deploying and performing the mission because of family concerns. In particular, members with families, female members, and younger members required the most attention as they coped with short-notice, deployment operations. The most adaptable groups, those who responded efficiently and effectively with a minimum number of conflicts, were the older, more experienced members; this finding emphasizes the value of mentoring by the senior NCO corps. The study described ways to minimize the problems by focusing on preparing members and their families by fostering communication between the deployed serviceman and spouse, educating spouses to take over money issues, augmenting child-care services, and providing employment assistance. Most important, it emphasized the need to communicate the squadron support network to the spouses and that the commander and first sergeant are available to help.³⁵

Commanders must recognize that readiness is not simply a training issue, as SORTS would suggest. It is, therefore, necessary to look beyond SORTS to assess a unit's readiness and consider

other factors. As the Washington Group research indicated, the most significant causal factor for absent-without-leave actions during Desert Storm was family problems.³⁶ This is a deployed mission-capability issue that requires definite top-down attention to maximize opportunities and minimize risks.

Readiness Evaluation Tools

SORTS. This is a Department of Defense (DoD)-wide readiness tracking and evaluation system designed to communicate unit readiness data to the President, Secretary of Defense, and Chairman of the Joint Chiefs of Staff to assist course-of-action decisionmaking during crisis situations.³⁷ The Air Staff watches readiness closely, with respect to the ability to perform certain missions, to mitigate periods of vulnerability.

Squadron commanders collect data on manning strengths, broken down by specialty codes and levels of training in each code, as well as equipment status. This is the primary means of collecting data on who is available and ready to execute a wartime tasking. The final assessment is a C-level rating from C1 (fully mission capable) to C5 (fully incapable). The final assessment is a subjective decision by the squadron commander, based on insight beyond the objective numbers. SORTS has sustained considerable criticism about its accuracy, ambiguous and unenforced reporting standards, and usefulness.³⁸

Some commanders perceive the commander's assessment as a reflection of their leadership and, therefore, may tend toward a higher readiness rating than warranted. The US Special Operations Command manager for the Joint Operation Execution Planning and Execution System (JOPES) estimated in 1996 that up to half the SORTS data that support JOPES was outdated and inaccurate. The report concludes that SORTS "is largely distrusted and ignored at the national and joint user levels."³⁹

Further, SORTS fails to capture more important aspects of readiness, such as field experience, family situation, skill proficiency, physical fitness, and attitudes of the troops which impact their ability to deploy, survive, and operate in contingency environments. In spite of these limitations, commanders must fully understand the message their SORTS reports communicate and also build other readiness assessment feedback systems to adequately evaluate the capability to deploy and sustain deployment taskings.

Mission Essential Task List (METL). A squadron-level METL contains the primary wartime tasks that support the contingency mission defined in the squadron's DOC statement. The METL includes mission-critical tasks taken from the Air Force Mission Essential Tasks, which is a portion of the overall DoD system of the Universal Joint Task List (UJTL). The UJTL contains tasks that support joint force commanders, the ultimate customers of the Services. This nested system of tasks is designed to help units focus training, exercises, manning strength, budget decisions, and organization toward achieving readiness for their wartime roles. Figure 4 captures the nesting of tasks from tactical to national strategic levels.

The METL provides a conceptual framework for squadron commanders to not only direct the unit but also monitor the status of readiness in these various mission areas. Units record METL status in a stoplight chart (green, yellow, or red) for each taskable deployment team. This allows MAJCOMs to monitor aggregate tasking capabilities, with visibility down to each deployable unit. Since units create their own METL elements, each squadron



Figure 4. Mission Essential Task Hierarchy⁴⁰

differs on what tasks it supports. For this reason, it is not possible to evaluate the shortfalls between the readiness elements and existing METLs and identify areas of concern for squadron commanders.

METLs are a relatively new concept to the Air Force, whereas the Army derives almost every action in conjunction with a METL. As the Air Force inspector generals (IG) move away from relying on SORTS and incorporate more evaluation of METLs and the capability aspect of readiness, units will need to ensure their troops understand and incorporate METLs into day-to-day business. In their current form, METLs do not provide timely feedback to squadron commanders on readiness assessment. They are refined annually and used as reference points during budgeting, new programs, manning reviews, and readiness inspection assessments. METLs are important, but they are not a viable way to track personnel readiness.

IG Exercise and Expeditionary Operational Readiness Inspection. The AMC Inspector General traditionally performed operational readiness inspections (ORI) by tasking a wing to execute large-scale deployments, demonstrating its ability to deploy and forward deploy as a measure of readiness and the ability to survive and operate in austere conditions. The current approach to inspecting readiness incorporates performance on real-world deployments and the evaluation of expeditionary concepts that typically combine portions of unit type codes (UTC) into *rainbow* units. This approach intends to reduce time away from home and evaluation operations as performed in actual contingencies.

The data collected from the evaluation of units are stored in a database called RUBICS (readiness UTC-based indicators for commanders) Cube, which combines a commander's semiannual assessments and the results of the IG exercise and EORI, based

on a unit's ability to perform its METLs for each UTC. The combined assessment develops a multidimensional matrix of results, forming a three-dimensional cube or four-dimensional series of cubes that highlight problem areas from a top-level perspective and allow drilling down and viewing the details of problems. This approach provides useful information to commanders for a more continuous readiness assessment, as opposed to a readiness surge every ORI cycle.⁴¹ Unfortunately, since inspections occur infrequently, the IG exercise and EORI process also fail to provide near real-time readiness status information.

Despite the promise and capabilities of these feedback mechanisms, if they are designed too theoretically or are too narrowly focused to omit the intangible aspects of individual readiness, they will also fail, as SORTS has failed, to capture certain critical aspects of true mission readiness. This concept emphasizes the need to ensure training and preparation experiences of the troops are captured and reflected in the METs. General Ryan emphasized METLs with the following statement:

Air Force organizations are authorized and encouraged to expand on the lower-level tasks in order to express their mission-specific requirements. This final detailing provides the necessary flexibility for major air commands, numbered air forces, and units to develop accurate and organization-specific Mission Essential Task Lists, which will identify the organization-specific essential tasks that must be performed to designated standards under specified conditions. Through this task assurance process, a commander will have the tools and indications to provide a continuous picture of the overall mission performance health of the organization. Careful application of the AFTL and METL approach will ensure our wings stay mission-healthy, our headquarters stay focused on the critical and important tasks, and we remain the most respected Air Force in the world.⁴²

JRAPIDS

The Joint Readiness Assessment, Planning Integrated Decision Support System (JRAPIDS) was a 1996 research study for the Chief of Staff of the Air Force that explored concepts and control capabilities necessary to support future operations as defined in Joint Vision 2025. The study described deficiencies in a SORTS-based readiness assessment system, which relies on subjective judgment with limited ability to extrapolate useful information on capabilities at the unit, joint force, and national level.⁴³ These limitations result from the process SORTS uses to capture a monthly snapshot that is based on a subjective interpretation of personnel, supplies, and equipment and fails to consider how these variables change. Therefore, to provide decision support for the future, DoD leaders require a dynamic system that automatically updates as personnel and equipment status aspects change.

The JRAPIDS proposal focuses on the *readiness output capability of the total force*, as opposed to the SORTS approach of tabulating the numbers and conditions of the available resources. This approach requires emphasis on the force efficiency, effectiveness, and flexibility as primary drivers of force management. It identifies some good, time-relevant considerations such as:

- Readiness for when? How long to [maintain a] *ready* [state]?
- Readiness for what? *Ready* to perform what tasks?
- Readiness for where? *Ready* for what theater or combat environment?⁴⁴

This concept of military readiness coexists with another concept of sustainability. A team with adequate readiness, capability, doctrine, and training proficiency to mobilize, deploy, set up operations, and execute for 5 days has a capability limitation if the needed mission duration is 90 days. Therefore, the critical measure for assessing mission readiness must consider and report on sustainability as well.⁴⁵

JRAPIDS explores the need to understand readiness in terms broader than SORTS allows and requires commanders to emphasize preparing forces and equipment in terms of the outcome capability to most efficiently make priority and funding decisions according to the importance of these outcomes. JRAPIDS would fulfill the decision support shortfalls created by SORTS and provide a better understanding of force capabilities, which is a much more pertinent factor of interest than the microanalysis of manning, training, and equipment.

Conclusion

Coverage of Desert Storm experiences and SORTS shortfalls round out the position that the intangible aspect of mobility readiness has valid implications, yet our tracking systems fail to give corrective actions to prevent uniformed members from deploying with inadequate preparation.

Implementation: A Commander's Role in Readiness

Do essential things first. There is not enough time for the commander to do everything. Each commander will have to determine wisely what is essential and assign responsibilities for accomplishment. He should spend the remaining time on near essentials. This is especially true of training. Nonessentials should not take up time required for essentials.

—General Bruce C. Clarke⁴⁶

Introduction

The concepts discussed throughout this article are useless unless implemented. There exists a short period of opportunity, when an officer takes command of a deployable squadron, to set the tone and communicate priorities. During the first few months of command, troops will observe and interpret the priorities, degree of resolve, and commander's commitment and, based on these observations, respond accordingly. If commanders enter this position of responsibility with a series of vectors pointing toward building up to and achieving readiness, they will better serve the combatant commanders by providing the forces and capabilities required in times of contingency. The key to success lies in the actions new commanders take within the first few months.

Readiness Defined

Readiness to deploy and sustain deployed operations is the mental and physical ability to effectively, reliably, and safely respond to a deployment order to carry out the contingency commander's intent. This capability-based definition incorporates further details such as accomplishing the deployment within the unit's DOC statement, in the prescribed timeframe, with the appropriate team, equipment, and supplies and carrying out the mission for the necessary duration with the ability to respond flexibly to changing scenarios and requirements. This type of readiness is not a product of attending annual refresher training or *filling the square* in achieving a 5- or 7-skill level. This type of readiness results from experience, teamwork, attitude, and persistent effort to overcome weaknesses. A commander's role in achieving this readiness product involves understanding the deployed environment and what it takes to survive and operate.

Of all the readiness-enabling factors, the first two, *establishing a mobility mindset* and *exercising with intensity*, were recommended by experts two times more often than the third and subsequent factors. Based on this observation, commanders ought to place proportional emphasis on these two. The other five factors could be considered best practices and operational suggestions on how to improve the efficiency and effectiveness of the deployment process.

It is this collection of seven factors and their supporting details that culminate this research. Before applying them to your squadron blindly, consider the fact that no two squadrons are identical. To lead effectively, it is necessary to know the unit. There is no better way to gain this insight than to deploy. This firsthand perspective will shorten the learning curve and help a commander relate to the needs of future teams.

Establish a contingency/mobility <i>mindset</i> .	Commander's emphasis
Exercise with <i>intensity</i> .	
<i>Standardize</i> mobility processes.	Best practices
Hold individuals <i>accountable</i> .	
<i>Train</i> core tasks and mobility skills.	
Create a sense of <i>status</i> for <i>mobile ready</i> .	
<i>Evaluate</i> using your most experienced troops.	

Table 1. Seven Enabling Factors for Personnel Readiness

Implementation Suggestions

When the dust settles after taking command, commanders face a steep learning curve as they drink from an information firehose. This part of the process is unavoidable, but to prevent reaching a plateau of mission status quo, the research supports taking the following steps to develop and maintain a healthy understanding and perspective of personal readiness.

- Deploy on a UTC tasking to experience a firsthand account of contingency operations.
- Review the squadron DOC statement, UTC tasking requirements, historical trip reports, and SORTS reports to develop a conceptual mission perspective.
- Review what the squadron does to prepare individuals for these challenges and how the commander tracks these preparation processes.

Existing tracking and evaluation procedures were discussed earlier emphasizing the fact that SORTS and METL fail to provide reasonable feedback. None of the systems track outcomes, except IG assessments, but a commander requires current readiness status frequently to adequately command. Therefore, commanders either remain in the dark and let readiness run on autopilot in a reactive mode or develop an understanding of readiness status blindspots and internal processes to overcome this shortfall and respond proactively as the environment changes. Since the challenge of readiness involves the feedback process and current methods exhibit limitations, the following discussion explores a commander's role in squadron exercises as a form of periodic readiness feedback.

Exercise Options. Since readiness proficiency is a perishable capability, it requires periodic refresher training. One relatively simple way to comprehensively track field experience currency while conducting refresher training is to set deployment currency shelf lives and execute realistic in-house exercises as needed. The research indicated that how exercises are conducted is just as important as having them at all. The following suggest how to implement an in-house exercise program.

- Select a standard UTC team to deploy a few miles from base to set up a portion of a bare-base operation and execute a specific aspect of the mission.
- Ask new senior airmen and staff sergeants to lead younger airmen in accomplishing certain objectives such as setting up communication systems and materiel-tracking systems and performing operator maintenance and troubleshooting on vehicles, aerospace ground equipment, and materiel-handling equipment.
- Challenge the team to work through difficult scenarios experienced by teams during IG exercises and contingencies.
- Mentor and discuss operational risk management concepts and how accidents could have been avoided.
- Throughout the exercise, expose the participants to role playing with rules of engagement, law of armed conflict, communications security, entry control-point procedures, and antiterrorism measures.

There are many other field-survival skills that challenge teams, but the point of this discussion is assessing no-notice capabilities. After performing this type of training assessment a few times, commanders can develop a fairly accurate sense of

how prepared the squadron remains as a whole. All these training actions ought to carry with them realism, a sense of urgency, and a challenge to push members beyond their comfort barriers and build a new sense of confidence and capability. It is this confidence that provides force multipliers when truly needed.

The officers, senior NCOs, and commanders play critical roles in the success of using an exercise as a readiness-building and assessing opportunity. This role comes down to participating actively and monitoring exercise progress. The research heavily endorsed the importance of the commander's being involved and refraining from the temptation to simulate events. As this research indicates by the number one readiness-enabling factor, mobility attitude is the most critical aspect. The commander sets the tone that leads to attitude. If the troops recognize that commanders care about readiness and expect all members to reflect their priority, they will most likely respond accordingly.

The research attempted to ascertain what truly enables personnel readiness and how a new commander should best focus energies to maintain an appropriate mobility posture.

Conclusions

This research began with the intent to address an important leadership problem seen in many operational squadrons from 14 years of personal observation. As a result of human nature and the shortfalls inherent in the current readiness-reporting systems, commanders often experience increased emphasis on home-station, day-to-day activity rather than ensuring all members of a squadron are prepared to deploy and operate on short notice in all conditions. Since readiness is a capability and not a tangible asset, it is difficult to proactively track and manage. Squadron commanders respond to challenges and projects given to them by group and wing commanders to propagate peacetime base-level activity whose fundamental mission is to organize, train, and equip forces. If taken to an extreme, squadron members expend limited resources on home-station priorities, which come at a cost to readiness.

As airmen go through basic training, they experience setting up a bare-base operating location and austere living conditions to provide an understanding of what they could be expected to perform. As they leave and are handed the *Airman's Manual*, they begin their first assignment with only an artificial understanding of how to survive and operate in true contingency conditions. Commanders, officers, and senior NCOs share the responsibility of replacing inexperience with ability-substantiated confidence through robust processes that monitor true readiness and consistently challenge outdated or ineffective skills and equipment with realistic exercise and training programs. By doing so, they will continue to make it happen, whatever aspect of it the National Military Strategy expects them to do. In doing so, they will continue to evolve as the constantly changing world continues to age and make obsolete the skills of yesterday. It is this effort of leaning forward that truly and effectively enables readiness.

This top-level look at the seven readiness-enabling factors provides a framework from which to compare how well an existing squadron prepares troops for contingency operations. It is the author's intent that this type of analysis and emphasis continue as standard operating procedures as MAJCOMs prepare new commanders for the challenges they will face.

(Continued on page 45)



EXPLORING THE HEART OF LOGISTICS

Development of a Master's Degree in Operational Logistics for Logistics Officers

Lieutenant Colonel Marcus Boyette, USAF

Wouldn't it be great if logistics officers could work toward and receive a Master of Science in Operational Logistics while qualifying in their career field?

The Chief's Logistics Review is bringing major changes to the Air Force. Many questions are brought to mind, especially when considering the new logistics readiness squadron and the logistics readiness officer. Are we creating generalists versus specialists? Is this the right approach? Is logistics readiness too much to get your arms around? Are the new training requirements too broad or demanding? What future repercussions are out there that we can address now? Let's examine the facts as well as the possibilities.

As everyone knows, the squadron structure has changed significantly. Transportation and supply squadrons are a thing of the past; they are being combined with the logistics plans function to form the new logistics readiness squadron. For the most part, traffic management, vehicle management, and fuels flights (and Air Mobility Command aerial port squadrons) will remain somewhat intact, while other functional processes will merge into distribution, readiness, and management and systems flights.¹ Former logistics plans, transportation, and supply officers will find themselves in dire need of education and training. How will the Air Force address this need? The Air Force vision for fully qualified logistics readiness officers will be achieved through training and experience to develop officers in three core competencies.

New accessions (second lieutenants) will start with a 6-week local orientation. This will be a commander's program focusing on key processes in preparation for technical training. They will then attend an 18-week course, which

will cover fuels, logistics plans, transportation, and supply. Graduates will return to their units, where they will begin on-the-job training (OJT) as they are assigned to work in one of the squadron's six flights. As they complete specified OJT tasks, their commander will certify them in each appropriate special-experience identifier. Six special-experience identifiers roll up into the three core competencies. An officer will be qualified in each core competency by completing one special-experience identifier applicable to that area.² In addition to earning the special-experience identifiers, logistics readiness officers must spend a minimum of 12 months in each core competency to be qualified. Full qualification should be achieved for most officers by the 6-year point, at which time the logistics readiness officer will receive the 21R3 Air Force specialty code (AFSC).³

Company grade officers who already have attended a pipeline technical training course are referred to as roundout officers. Roundout officers will be awarded the 21R3 AFSC temporarily. However, they must complete exportable minicourses (fuels, logistics plans, transportation, and supply) for courses they have not yet attended. In addition, they must gain experience in one additional competency within 3 years.⁴

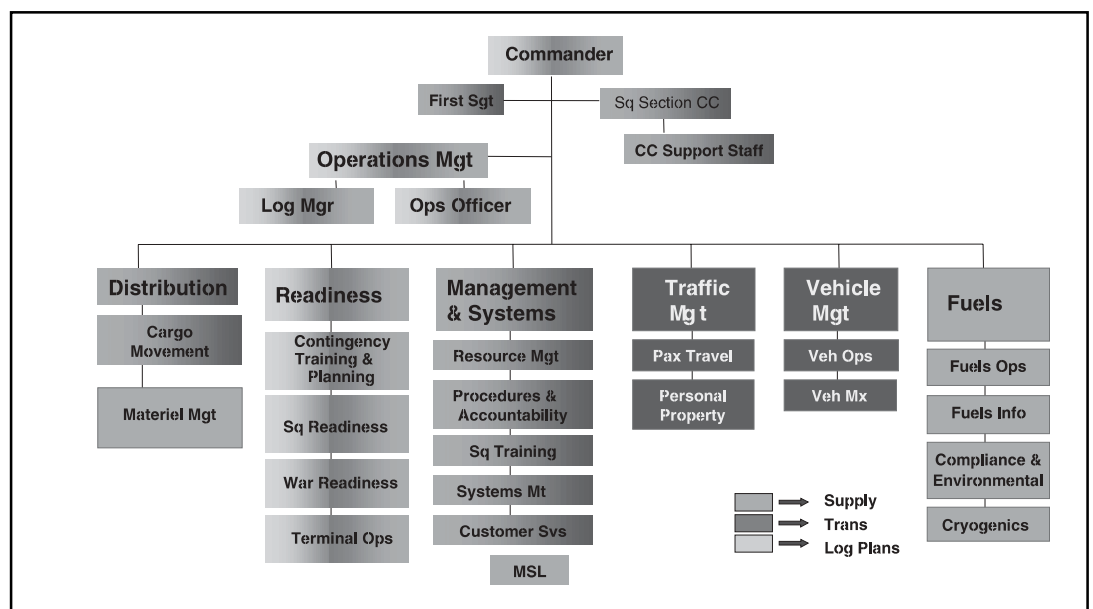


Figure 1. Approved LRS Structure

Both new accessions and roundout officers will be considered to be in upgrade status and will follow gate system requirements. Field graders are grandfathered but highly encouraged to complete exportable minicourses. Professional continuing education will be available via the Air Force Institute of Technology (AFIT) for all levels.⁵

Okay, that all sounds good. Problems will come up, but we can work through them. What about master's degrees?

The master's degree is not mandatory, but any officer career path you look at shows completion of a master's degree by the 10-year point or at least prior to the major's board. Let's face facts; it's a way to differentiate between individuals, all other things being equal.

What avenues are currently available to complete a master's degree?

AFIT is a well-known avenue for *loggies* to accomplish this objective. AFIT offers a Master of Science in Logistics Management at Wright-Patterson AFB, Ohio. This 18-month program is the Air Force *master's degree for loggies*. The degree is further specialized in acquisition logistics, logistics management, supply management, and transportation management.⁶ Through AFIT, the Air Mobility Warfare Center, adjacent to McGuire AFB, New Jersey, offers a Master of Science in Air Mobility. It is a 13-month program that offers many courses similar to those offered by AFIT's Logistics Management program.⁷ Graduates of AFIT master's programs go on to designated advanced academic degree positions and, consequently, do great things for the Air Force. These degree programs are obviously outstanding but offer opportunity to complete a master's degree to only a small percentage of the total population of Air Force *loggies*.

The majority of Air Force officers complete their master's degrees through a variety of off-duty programs. These programs are run either by local colleges or by colleges catering specifically to the military or professional people, with satellite programs at numerous locations. Unlike attendance at AFIT as a full-time student, off-duty education requires all class attendance, studies, papers, and the like to be completed on personal time. A sharp, young officer might spend 10 to 12 hours in the squadron and then press on to class or home to study or work on a paper. It is already difficult to achieve balance between duty and family, and a degree program only makes the situation more complicated.

So what is the issue? Increased time, training, and focus required to qualify as a logistics readiness officer will reduce the time available and focus possible to complete an off-duty master's degree by the 10-year point or prior to meeting the major's board. Things are already tough, and now they are going to get tougher. If this sounds like whining, let's take a look at the aircraft and munitions maintenance crowd. Young officers are looking at 10-, 12-, or 14-hour days; nights; weekends; and holidays. Contracting—again, long hours. Who's got time for a master's degree? What's the most expedient avenue to get one?

Wouldn't it be great if logistics officers could work toward a Master of Science in Operational Logistics while qualifying in their career field? What if this master's degree awarded them credit hours for Air Force formal training? So they are actually working toward their master's simply by qualifying in their career field. In an educational sense, a Master of Science in Operational Logistics would tie together the multiple disciplines of the logistics readiness officer. It would also cover maintenance and

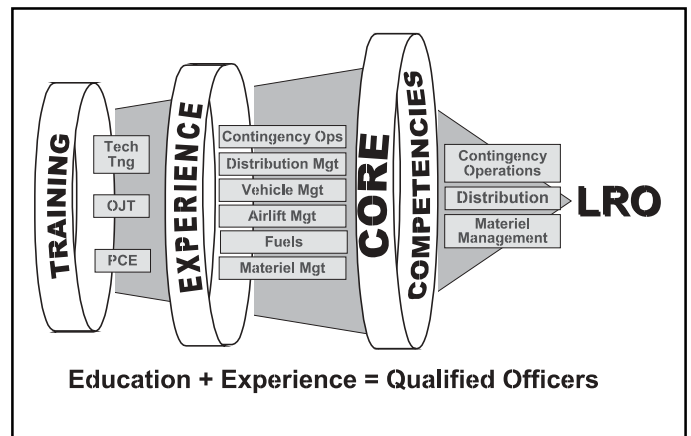


Figure 2. LRO Vision

production management for aircraft and munitions maintenance officers, as well as acquisition logistics for the contracting officers.

This is not rocket science. It's a win-win for everybody. So what's the best approach? What are the alternatives?

Course of Action 1

Partner with AFIT, to offer an accredited nontechnical or semitechnical master's program focusing on operational logistics and geared toward off-duty students. This program should not be on the same level of difficulty as an in-residence AFIT master's degree or intended to fulfill advanced academic degree requirements. It must have distance-learning (either online or via correspondence) capability to allow *loggies* at any location to complete the course work. Papers could be mailed to AFIT for grading. Testing would need to take place through the base education office.

Key. Logistics officers must receive credit hours for formal training and certifications.

Advantages.

- Lends itself toward central management by the Air Force.
- AFIT already has logistics-focused courses to draw from.

Course of Action 2

Partner with civilian colleges that have specialized master's programs in logistics to offer a program tailored for off-duty military students. Again, the program for the Air Force should be nontechnical or semitechnical with a focus on operational logistics, and courses must be available either online or via correspondence. Papers could be mailed to the college for grading, and testing could take place through the base education office.

Key. Logistics officers must receive credit hours for formal training and certifications.

Advantages.

- These colleges already have logistics-focused courses to draw from.
- The degree would be from a regionally accredited college.

Course of Action 3

Partner with civilian colleges that have numerous extended-campus programs at military bases. Request development of a nontechnical or semitechnical master's program focusing on operational logistics. Students would be able to attend classes

at worldwide satellite locations. Distance learning must also be available for individuals in unserved locations. Papers could be handled by the local instructor or mailed to the college for individuals at unserved locations. Testing could take place through the base education office.

Key. Logistics officers must receive credit hours for formal training and certifications.

Advantages.

- The degree would be from a regionally accredited college.
- These colleges are already operating in numerous worldwide locations.

Key Elements

- Logistics officers must receive credit hours for formal training and certifications.
- Capability to continue course work at any location

Why a master's degree focusing on operational logistics?

- Operational logistics is very relevant to the daily work of logistics officers.
- The program would build an increased sense of professionalism into the logistics officer corps.
- It would improve the ability to master multiple aspects of the logistics business.

Is there a demand? Just walk around and ask the opinion of young logistics officers, and you will have your answer. Look

outside logistics; rated officers might desire to take part in this type program. One could push this theoretical argument even further. Look outside the Air Force; Army, Navy, and Marine Corps logisticians would probably find value in these same master's programs. With that kind of mass appeal, a really solid program could be built to suit a variety of backgrounds.

Things can stay as they are, and the best will still survive—even excel. It is possible for any logistics officer to complete a master's degree. However, with a little more planning, we could really help the individuals our country will depend on to lead tomorrow's Air Force.

Notes

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Is Agile Logistics Focused Logistics in Hiding?

Lieutenant Colonel Nancy Stinson, USAF

Should effects-based logistics be developed to replace agile logistics? Does the logistics career field need its own published doctrine?

Any military professional can make the statement, "Logistics is the key to successful operations in a war or wartime contingency," and most people would agree. However, ask those same people about logistics doctrine, and most of the time you will probably draw a blank stare, an *I don't know shrug*, or perhaps a smirk of indifference. I do not think you can blame anyone for giving one of those responses; after all, what is logistics doctrine anyway? Better yet, where is it published? If you look through today's published doctrine, it would be hard to find a definition of logistics in concert with current doctrine. Where does doctrine define logistics core competencies in a manner that would agree with Air Force Doctrine Document 2-1, *Air Warfare*, which defines effects as "the operational or strategic-level outcomes that Air Force functions are intended to produce"? Why not take that statement and add logistics to it and define effects "as the operational, strategic, and logistics outcome that Air Force functions are intended to produce"? Could the introduction of an effects-based logistics concept improve the Air Force expeditionary combat support concept? This approach could build upon the Department of Defense concept of Full Spectrum Dominance and Focused Logistics. How can effects-based logistics be defined? How about the "desired logistics effects in support of operational or strategic-level outcomes that the Air Force functions are intended to produce"?

The introduction of logistics in this definition would eliminate the casual approach to preplanning the materials required for the specified outcome intended for the operation. More attention would be directed toward the development of refined logistics procedures and technology that will aid in the battle. With the evolution of just-in-time supply and two-level maintenance, the precision with which logistics requirements can be satisfied has been increased dramatically. That means there is a requirement for a far more integrated relationship between logistics and operations. Because dramatic battlefield successes are achieved increasingly over very short periods of time, the *phases* of a campaign can be moved through much faster. This means that logistics requirements need to focus on anticipating battlefield results and quickly adapting logistics flows to what happens on the battlefield. Instead of being reactionary, logistics must be anticipatory—two steps ahead of the next set of requirements. This is effects-based logistics because, as the battlefield changes, logistics support not only changes but also, if done in an effects-based approach, can be used by the operators to leverage capabilities and shape the branch and sequel courses of action. The rapid response of today's operations will determine the size and amount of logistics support, subsequently requiring a higher speed and accuracy of logistics operations than have ever attained before. This requirement for rapid logistics support will continue to increase as the new century and a new space-

(Continued on page 46)

Current Logistics Research



AFMC Management Sciences Division Logistics Analysis

Richard Moore, AFMC

Questions are never indiscreet. Answers sometimes are.

— Oscar Wilde

Air Force logisticians are constantly faced with difficult decisions. “Should I buy part X or part Y?” “Which requisition should I satisfy first?” “Which part should I repair first?” Not only are these questions themselves difficult, but the tremendous impact the answers have on the readiness of the Air Force intensifies the decision. The incredible number of these decisions being made every day can be overwhelming, but through the prudent application of professional analysis, logisticians are able to make the best decisions supporting the warfighter.

Providing professional analysis support for these types of decisions is the primary business of the Management Sciences Division of the Air Force Materiel Command (AFMC). The majority of the analysts have advanced degrees in technical areas such as operations research, mathematics, engineering, and management sciences. Although the division is a part of the Directorate of Plans and Programs, it often performs studies and analyses for clients outside the directorate, particularly in the AFMC Logistics Directorate

In 2001, Management Sciences devoted a major portion of its efforts toward implementing and improving methods for managing materiel spares and further expanded its scope to other AFMC mission areas (product support, depot maintenance) where it could provide decision-support products and analytic tools could be applied. Generally, the tools and products helped the mission areas determine requirements, allocate resources, execute support actions, and assess impact. The following summary highlights three of the most significant spares management studies and provides an overview of other contributions.

Customer-Oriented Leveling Technique

The depots have fixed funding each year for buying Defense Logistics Agency (DLA)-managed spare parts in support of

depot-maintenance operations. The funding varies from \$600M to \$800M a year, which can be spent on roughly 300,000 parts across the three depots. How should this money be spent to best support the depot maintainers and, ultimately, the warfighter?

Each of the air logistics centers (ALC) had developed its own answers to this question, but none adequately accounted for various factors that affect supply support:

- Available spares budget
- Expected responsiveness from DLA for each part
- Cost of each part
- Variability in demand for each part

Even more important, none of the previous policies explicitly targeted customer support when setting spares levels.

Management and Sciences worked with the Supply Division and the depots to develop a standard depot-stockage policy for AFMC. The policy became embedded within a Management Sciences-developed, database-driven tool—the Customer-Oriented Leveling Technique (COLT). A COLT was developed to determine optimally which DLA-managed parts the depots should buy to achieve the lowest possible, expected customer wait time for a given amount of General Support Division funding. With COLT customer wait time, reductions of up to 80 percent may be possible for the same level of funding.

COLT was implemented across all three depots by November 2001. The actual customer wait time across all depots was baselined on 1 October 2001 at 6.94 days and, as of 1 July 2000, had fallen to 3.88 days—a 44-percent reduction. As a result of these dramatic successes at the depots, efforts have begun to expand COLT to the base level at other major commands (MAJCOM).

Evaluation of Commercial Off-the-Shelf Forecasting Packages

Which spare parts will my customers be requesting in the future? There is no more fundamental question in spares management than this; yet, it is also one of the most difficult. If the answers were known, the savings in inventory costs and improvements in readiness would be tremendous. Because of this, the search for this logistics *Holy Grail* has led many to suggest that commercial industry must have better forecasting techniques than the Air Force. Management Sciences evaluated the

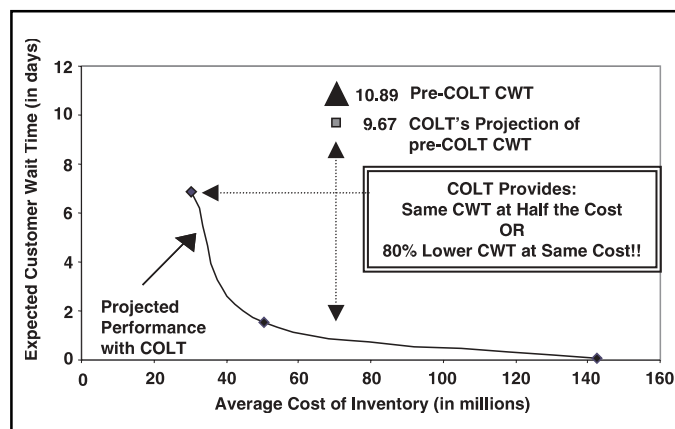


Figure 1. Comparison of Cost and Performance from COLT Versus Previous Policies

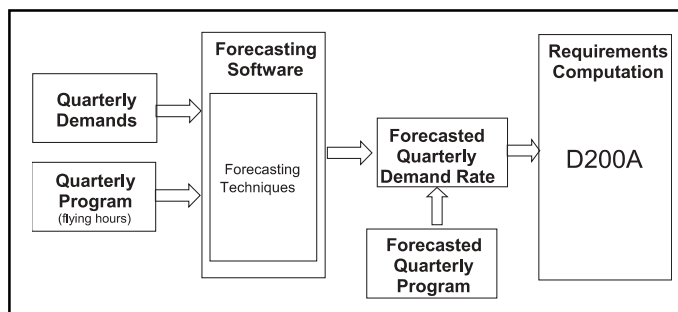


Figure 2. Overview of the Demand Forecasting Process in D200A

performance of commercial-off-the-shelf (COTS) packages relative to the performance of the forecasting techniques in AFMC's Secondary Items Requirements System (SIRS or D200A), which is used to compute future spares requirements for recoverable items.

The purpose of the study was to determine whether or not a commercial forecasting software package with an expert selection capability could generate more accurate forecasts than the four techniques currently being used in D200A. A forecasting software package with expert selection capability automatically determines what technique, from a set of different forecasting techniques, to use when forecasting future values of a time series. The study examined six different COTS forecasting packages. Each package was used to generate forecasts for stock numbers from several samples of data—including random samples, a sample of items with high mission-incapable hours, a sample of items with high demand-to-program ratios, and a sample of low-demand items. The forecasting accuracy of each commercial package was compared to the forecasting accuracy of the 8-quarter-moving-average technique from D200A. The 8-quarter moving average was selected as the baseline for comparison because it is currently the most frequently used forecasting technique in the system.

The results showed that none of the commercial forecasting packages consistently generated significantly better overall forecasts than the eight-quarter moving average for each of the data samples. Allowing the expert selection function to choose from all the available techniques generally resulted in worse accuracy than limiting the set of available techniques to more conservative techniques; in other words, techniques that do not project a linear or cyclical trend into the future. This is because the errors associated with the forecasts from these

techniques can be large when the trend projected into the future does not materialize, especially when forecasting 2 or 3 years into the future. The results of the study were briefed to the AFMC Logistics Directorate and the Air Force Directorate of Supply, and based on the results, the decision was made to not implement a commercial forecasting package within D200A. Instead, a tool is being developed that automatically selects between the four forecasting techniques already within the system. This tool should be fielded as part of D200 in January 2003.

Spares Campaign Development and Deployment

"What improvements can the Air Force make to its spares management processes?" Much of what Management Sciences does involves improving spares processes, but in 2001, much time was spent supporting an Air Staff-led initiative called the Spares Campaign, to corporately answer this question. The purpose was and is to transform fundamental spares support processes to reverse the declining readiness trends of the 1990s.

The initiative began with the formation of five cross-functional teams of subject-matter experts from across the entire Air Force tasked with identifying shortcomings in the current spares support processes and developing options for fixing them. Management Sciences played a leading role on two of the teams: cochaired the Requirements Determination Team and was a significant contributor on the Requirements Allocation, Execution, and Distribution Team. After meeting for 3 months and developing hundreds of pages of issue papers, the recommended fixes from all the teams were aggregated into eight key initiatives, which were approved for implementation at the fall 2001 Corona:

- Establish virtual single-inventory control point.
- Improve demand-and-repair workload forecasting.

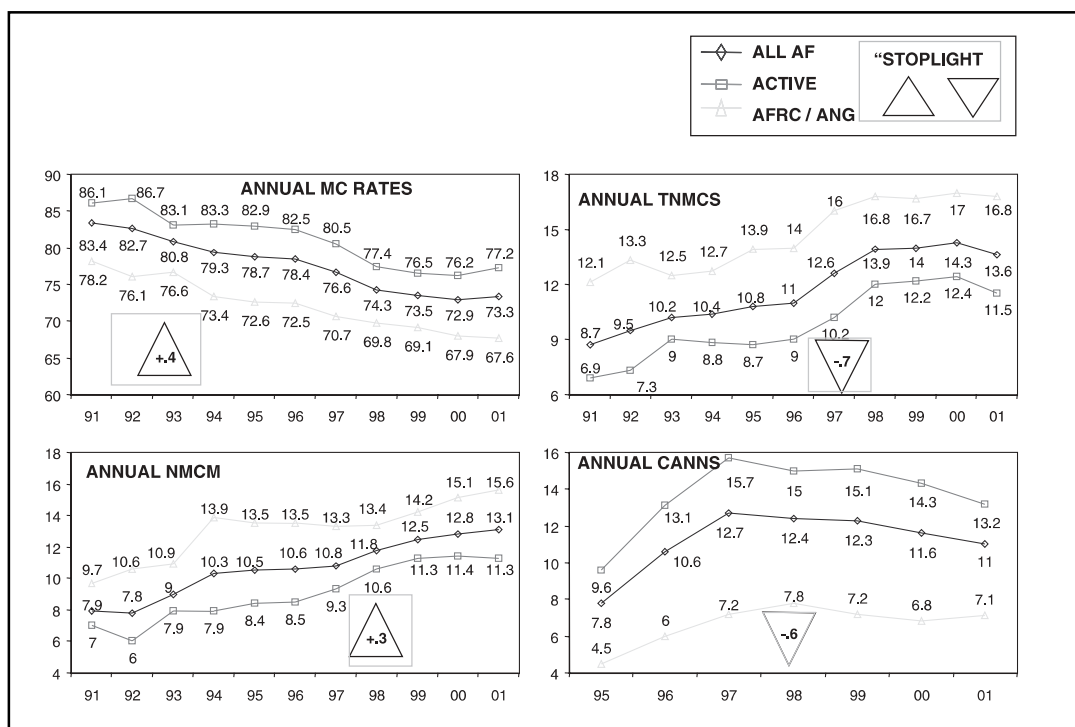


Figure 3. Aggregate Annual Aircraft Rates—FY91-01 (August 2001)

- Improve spares budgeting.
- Change depot-level repairable pricing structure.
- Improve financial management.
- Align supply chain management focus.
- Standardize role of regional supply squadrons.
- Adopt improved purchasing and supply management.

Each of these initiatives has many specific recommendations, which total 37 across the eight areas. AFMC is responsible for implementing 12 of the 37 recommendations, and Management Sciences has significant involvement in 5 of them:

- Centrally compute buy or repair priorities to meet weapon-system availability targets.
- Push full-funding stock levels to users; rely on execution processes to ration funds.
- Implement a commercial forecasting methodology in the AFMC Secondary Item Requirements System (D200A).
- Correct inconsistencies between requirements and execution.
- Modify D200A to identify requirements based on weapon-system availability, specific readiness goals.

The analysis efforts to help the Logistics Directorate implement these recommendations are documented throughout Management Sciences 2001 report. Despite the significant effort committed to the Spares Campaign, an increased effort is anticipated to support Spares Campaign deployment.

Other Contributions

Management Sciences also helped the logisticians of the Air Force in the following areas:

- Developed estimates of joint strike fighter (JSF) spares requirements for various readiness targets. Assisted with an evaluation of Air Force and Navy computational tools, and based on these efforts, the JSF program office selected the Air Force tool (Aircraft Sustainability Model) for calculation of initial spares quantities.
- Recommended whether the AFMC depot-repair process should use requisition objective holes or back orders to identify customer spares shortages. Demonstrated that back orders are the more accurate statement of shortages and highlighted numerous data disconnects affecting both methods and impacting AFMC decisions to buy and repair parts.
- Explained to the Air Mobility Command Director of Logistics why the AFMC stock-leveling process (readiness-based leveling [RBL]) sets stock levels on some parts to zero and highlighted the impact on overall spares availability. Resolved the concerns and showed that the process is functioning as intended.
- Provided technical and analytical support for the implementation and enhancement of the RBL system, resulting in an improved and more efficient RBL model. Also provided quarterly reports to the Logistics Directorate senior management, highlighting changes in spares levels at each air logistics center.
- Provided technical and analytical support for the implementation and enhancement of the D200A, primarily focusing on the Aircraft Availability Model. Working with

the Logistics Management Institute, the efforts produced 27,000 additional units of spares at a cost of only \$16M. Also computed additional spares for consumable items to increase base fill rates by 6 percent.

- Evaluated the results of an external analysis that suggested AFMC was expending resources to repair items that the MAJCOMs never use (*buy*), resulting in major cash losses. Found no evidence that AFMC was repairing the wrong item and highlighted data issues that affected the external analysis.
- Determined whether the parts most impacting customer readiness were being repaired by the depots. Found that only 44 percent of these critical parts were candidates for repair as part of the AFMC standard organic depot-repair process, and only 25 percent of these were being repaired in sufficient quantities to satisfy all customer needs.
- Continued to support the implementation of the Execution and Prioritization of Repair Support System (EXPRESS), which prioritizes depot-repair and distribution actions. Developed a new prioritization math model for EXPRESS to support MAJCOM centralized intermediate repair facilities; demonstrated an approach that was eventually approved for improving spares demand-forecasting capabilities in EXPRESS.
- Identified the readiness impacts of alternative spares support policies (*contingency flags*) for actively engaged units on those units and the remainder of the Air Force fleet. Working with the Air Force Logistics Management Agency, showed that strictly enforcing the existing policy can make spares available to repair 43 grounded aircraft; limiting the existing policy to only actively engaged units makes spares available to repair 93 broken aircraft. The Chief of Staff approved limiting the current policy to only actively engaged units.
- Correlated workload and the number of item managers at each air logistics center as a baseline for determining future manpower requirements. Developed a mathematical relationship between workload and number of item managers based on regression analysis. Integrated product team members are reviewing the preliminary model for potential use at each air logistics center.
- Evaluated whether unifying the processes for prioritizing depot repairs (EXPRESS) results in better support for AFMC's customers. Analysis showed that an increase in expected aircraft availability of up to 8 percent could be realized when computing spares using a unified computation, versus a separate computation for each air logistics center.
- Developed a tool for supply chain managers to objectively develop defensible metric targets (for example, issue and stockage effectiveness, back orders). Provided a prototype tool to two supply chain managers (WR-ALC Support Equipment and Vehicle Management Directorate and OO-ALC Commodities Directorate)
- Initiated and validated an offline process, motivating bases to evacuate unneeded broken parts. This will save spares funding and maintenance workload by preventing the base-level repair of items that have more assets than requirements.
- Evaluated the processes and benefits of the WR-ALC Workload Planning Trial, which overrides the automated process (that is, EXPRESS) for inducting items into depot repair. The test was inconclusive as the performance for the items in the test closely followed those items not in the test.

- Evaluated the responsiveness of depot-repair support received by foreign military sales (FMS) customers compared to Air Force customers. Although the results showed that FMS customers did not receive worse depot-repair support, the study was well-received by FMS representatives because it provided objective analysis of a perceived problem.
 - Developed a database interface tool to facilitate Air Force and FMS logistics response-time analysis for recoverable items. The tool automates a previously cumbersome analysis process and makes statistical results readily accessible resulting in more satisfied FMS customers and more informed Air Force decisionmakers.
 - Supported the performance-based delivery on demand initiative for contract repair by designing a convenient means of monitoring contractor performance. After discovering deficiencies in required data systems, the focus has shifted to enhancing the systems before developing the automated tool.
 - Ensured the Forward-Looking Availability and Reliability Simulation Model reacts to changes in inputs as expected and is accurate in forecasting availability rates. After numerous changes were submitted to the contractor, the model was verified and validated for use on the E-3 aircraft.
 - Developed a simulation model for the Focused Logistics Wargame 2001 that provides quantitative insight into AFMC's projected capability to support a multiple-war scenario. Provided a prototype model that simulates 90 days of flying activity and associated depot-maintenance activity for 35 weapon systems in a wartime environment.
 - Investigated alternatives to improve the subjective process for establishing wartime stock levels for electronic warfare components. Initial efforts examined several sources for parts demand data and identified the Standard Base Supply System as the most suitable; project is ongoing.
 - Helped AFMC understand more clearly the relationship between notional readiness spares package policy changes and computed stock levels. Several factors cause the computation to be relatively insensitive to certain changes in the scenario being modeled; research is ongoing to identify the broad impact of these factors.
- Mr Moore is chief, Analytic Applications, Management Sciences Division, Air Force Materiel Command, Wright-Patterson AFB, Ohio.*



(Vehicle Fuel-Consumption Reporting continued from page 3)

- Modernized OLVIMS
- Defense Energy Support Center (DESC) Fuels Automated System (FAS) Enterprise Server (FES), commonly referred to as the *Purple Hub*
- GSA for leased vehicles
- System upgrades and or new data-reporting models and methodologies for collecting fuels consumption data

Review of vehicle fuel consumption targeted the registered vehicle fleet, which includes both government-owned and leased vehicles. Fuel consumption includes traditional petroleum fuel (unleaded gasoline, diesel) as well as alternative fuels (compressed natural gas, ethanol, biodiesel).

Data for bulk issue of fuel to vehicles (fuel not obtained through an automated system) are not fed to DESC by vehicle registration number; thus, OLVIMS cannot capture that usage. Moreover, according to the OLVIMS manual, data on bulk-issue fuel obtained using a government credit card are fed to accounting and finance, which, in turn, feeds it into an automated system. OLVIMS then retrieves the data through base supply's D22 transmit files. However, data concerning fuel issued with a government credit card are no longer being obtained through the Standard Base Supply System (SBSS) because fuel accounting was transferred to DESC.

Discussion and Analysis

As a first step, regulatory guidance and policy were reviewed to determine fuel-reporting requirements and guidance available to the field for collecting and processing fuel-consumption data. Next, existing Command Air Force Vehicle Information Management System (CAFVIMS) data on fuel consumption and vehicle usage were analyzed to see what problems could be addressed during base visits and in an Air Force-wide questionnaire.

A series of base visits to several major commands (MAJCOM) were conducted. During these visits, data collectors (fleet management and maintenance control and analysis personnel) were given the opportunity to provide their perspective and feedback on collecting fuel data and processing it into OLVIMS.

Questionnaires were also sent to all Air Force bases, requesting help in identifying:

- Alternative fuels used and how data are collected for government-owned and leased vehicles. Is there a standard for this data collection, and are the data being fed into automated systems?
- Nonautomated fuels issued. Are the data on fuel issued being fed into automated systems?
- Off-base fuel purchases with bulk-issue government credit cards. How are the data for these purchases being fed back into automated systems?

To understand the flow of fuels data from base fuels to DESC to OLVIMS for government-owned vehicles, the process was thoroughly described and flowcharted to ensure accuracy. Experienced transporters, in the field and at AFLMA, were drawn into the effort.

Quarterly and annual CAFVIMS data on vehicle usage and fuel consumption were continually reviewed to see if it was reasonable and accurate and, if not, if there was a way to estimate the degree of inaccuracy and adjust fuel-consumption data to provide a more accurate baseline for reporting mandated petroleum fuel-consumption reduction.

Policy Requirements for Vehicle Fuel-Consumption Reporting

Throughout the analysis, the questions that always came up during discussions were, "Why do we need to know how much fuel is consumed for each vehicle? Why don't we just track overall fuel usage for vehicles?" From a nontransporter's view, these are fair questions. However, since these data must be presented and explained for Department of Defense (DoD) and congressional

reports, this level of detail is required. The following are public laws and DoD policy that require fuel-consumption reporting:

- *Energy Policy and Conservation Act*, as amended (42 USC 6201 et seq)
- EPCA of 1992 (Public Law 102-486), United States Code
- EO 13149, 21 April 2000, *Greening the Government through Federal Fleet and Transportation Efficiency*
- EO Order 13149, October 2000, *Greening the Government through Federal Fleet and Transportation Efficiency, Guidance Document for Federal Agencies*
- Code of Federal Regulations, Title 41—*Public Contracts and Property Management*
- DoD 4500.36R—*Management, Acquisition & Use of Motor Vehicles*

Both vehicles and nonvehicular equipment use fuel, so there is a need to differentiate the specific fuels used. The level of detail required is best explained by the reports required from the policy references previously cited; in particular, the Agency Report of Motor Vehicle Data (Standard Form [SF] 82) and the Federal Automotive Statistical Tool (FAST) worksheet.

SF 82 is used to report agency vehicle inventory, cost, and operating data to GSA (required by DoD 4500.36R). Reportable vehicles include all sedans, station wagons, buses, ambulances, carryalls, trucks, and truck tractors that operate on petroleum-based fuels (gasoline, diesel, gasohol, propane, methane, or a combination of these fuels when these vehicles are integrated into the normal agency fleets). Excluded are semitrailers, trailers and other trailing equipment, trucks with permanently mounted equipment (generators, air compressors), firetrucks, electric and hybrid-powered electric vehicles, motorcycles, and military-designed motor vehicles. The requirements for this report show why accurate fuel data are required for each vehicle. Completion of the form requires vehicle grouping, fuel cost per grouping, and fuel type per grouping (Figures 1 and 2).

The FAST worksheet is driven by the data requirements in EO 13149. As mentioned, one requirement of the Executive order is to reduce consumption of petroleum products by 20 percent by FY05. The following was taken from the guidance document explaining ways to achieve the goal of the Executive order.

The requirement that agencies must use a combination of energy efficiency and alternative-fuel use activities to successfully achieve the goal of this order.

- An agency will need to ensure the use of alternative fuels in alternative-fueled vehicles a majority of the time that the vehicles are in operation.
- An agency is required to increase fuel efficiency of new light-duty vehicle acquisitions by 1 mile per gallon by FY02 and 3 miles per gallon by FY05.

The 20-percent reduction in petroleum consumption by FY05 takes into consideration an agency's entire fleet (except fuel consumption in exempt vehicles), including light-, medium-, and heavy-duty vehicles.

Under the EPCA, exempt vehicles include military tactical, law enforcement, emergency, and medium- and heavy-duty vehicles and vehicles geographically located outside a covered metropolitan statistical area. However, under EO 13149, only military vehicles, law enforcement, and emergency vehicles are considered exempt.

FAST is used to gather and prepare data for entry into the web-based FAST Tracking System and requires the same level of detail

as the SF 82. As outlined in EO 13149, Guidance Document, paragraph 2-3, Annual Reporting Requirements and the FAST tracking system:

The FAST tracking system provides a convenient format for all federal fleets to use in preparing progress reports toward meeting the goals of the Order while providing the Department of Energy (DoE) with flexibility in analyzing and presenting the data to OMB, the White House, and Congress in the various reporting formats necessary. In addition, FAST will collect and process data for SF-82 reporting, beginning with FY 2000.

Figures 3 and 4 show portions of the data required.

Along with reporting requirements, data are also collected for efficient and effective management of motor vehicle assets. Fuel data make up one portion of the operating data for each vehicle and are used not only for local management requirements but also to help determine replacement criteria for each vehicle type. Each year, the Warner-Robins Air Logistics Center (WR-ALC) feeds all the vehicle data into a vehicle replacement model that "updates vehicle life expectancies in the Vehicle Management Index File and to assist with vehicle procurement decisions" (*Vehicle Replacement Model Upgrade*, AFLMA project number LT199827600).

The accuracy of data input into any system is, to a great extent, dependent on the motivation of those entering the data. That motivation is usually based on, "What's in it for me?" or "How does this bean-counting task affect my job?" Thus, knowing what drives the requirements for vehicle fuel data is the first step in ensuring accurate data and helps answer why vehicle-level detail is needed.

Vehicle Fuel Data Flow. Fuel is obtained for government-owned vehicles through base gas stations, organizational bulk-fuel tanks, and commercial service stations. The fuel-consumption data must be fed into the OLVIMS from each of these. The major processes associated with vehicle fuel data reporting start at a refueling point; for example, base gas station or bulk-fuel tank. They continue by flowing through the base fuels management office to the DESC Purple Hub and then on to OLVIMS. Figures 5, 6, and 7 graphically illustrate the various ways fuel may be obtained.

Base Gas Station. The collection of fuel data from the base gas station starts when a vehicle refuels (Figure 5). Two methods for collecting fuel-consumption data are the vehicle identification link or Air Force Form 1252, USAF Vehicle Serv-O-Plate. Bases supported by an automated fuel service station use the VIL key. According to Air Force Manual (AFMAN) 23-110, *USAF Supply Manual*, volume 1, part 3, paragraph 1.78.1, vehicle operations and the unit vehicle control officers are responsible for ensuring information on the vehicle identification link and Serv-O-Plate is correct. The base fuels management office (BFMO) codes VIL keys and embosses Serv-O-Plates according to information provided by vehicle control officers and vehicle operations. For bases not supported by an automated fuels service station, vehicle operations is responsible for embossing the Serv-O-Plates.

The information contained (vehicle registration number, fuel type, DoD activity address code/stock record account number [DoDAAC/SRAN]) on the VIL key and Serv-O-Plate is critical for the fuel-consumption data to flow to OLVIMS. One example of possible errors would be an incorrect registration number or

AGENCY REPORT OF MOTOR VEHICLE DATA (Read instructions carefully before completing this form.)		FISCAL YEAR (ending Sept. 30)	VEHICLE USED FOR:	DEPARTMENT OR AGENCY	DATE PREPARED	INVENTORY REPORT CONTROL NO.	
			<input type="checkbox"/> DOMESTIC <input type="checkbox"/> FOREIGN	BUREAU, SERVICE, ETC.		1182-GSA-4W	
DESCRIPTION	LINE NO.	TOTAL (All vehicles)	SEMI-TRAILERS AND TRAILERS	AMBULANCES	BUSES (12 or more passengers)	TRUCKS & TRUCK TRACTORS BY GROSS VEHICLE WEIGHT (MOTOR VEHICLES)	
						4,500 LBS. & UNDER	4,501 LBS. TO 16,000 LBS. & OVER
						4,500 LBS. & UNDER	4,501 LBS. TO 16,000 LBS. & OVER
SECTION I AGENCY-OWNED AND LEASED VEHICLES	1						
AVERAGE COMMERCIAL LEASED VEHICLES	2						
TOTAL COMMERCIAL LEASED VEHICLES	3						
SECTION II AGENCY-OWNED VEHICLES (Large fleet, 5,000 or more vehicles)	4						
FUEL COST	5						
DIRECT MAINTENANCE COST	6						
INDIRECT COST	7						
TOTAL COSTS (Estimated)	8						
TOTAL MILES Kilometers OPERATED	9						
VEHICLE CLASS		OWNED	LEASED	REMARKS			
CLASS I - SUBCOMPACT	10						
CLASS II - COMPACT	11						
CLASS III - MIDSIZE	12						
CLASS IV - LARGE	13						
CLASS V - LIMOUSINE	14						
TOTAL	15						
CONTACT FOR ADDITIONAL INFORMATION		NAME		TITLE		RESPONSIBLE OFFICIAL	
		AREA CODE		PHONE NUMBER		EXTENSION	
		FAX NUMBER		EXTENSION			
AUTHORIZED FOR LOCAL REPRODUCTION Previous edition obsolete		STANDARD FORM 82 (REV. 3-2000) Replaces SF 82-100, SF 82-101, SF 82-102, SF 82-103					

Figure 1. SF 82 Agency Report of Motor Vehicle Data (page 1)

AGENCY REPORT OF MOTOR VEHICLE DATA (Read instructions carefully before completing this form.)		FISCAL YEAR (ending Sept. 30)	VEHICLE USED FOR:	DEPARTMENT OR AGENCY	DATE PREPARED	
			<input type="checkbox"/> DOMESTIC <input type="checkbox"/> FOREIGN	BUREAU, SERVICE, ETC.		
DESCRIPTION	LINE NO.	TOTAL (All vehicles)	SEMI-TRAILERS AND TRAILERS	AMBULANCES	BUSES (12 or more passengers)	TRUCKS & TRUCK TRACTORS BY GROSS VEHICLE WEIGHT (MOTOR VEHICLES)
						4,500 LBS. & UNDER
						4,501 LBS. TO 16,000 LBS. & OVER
SECTION IV PART A AGENCY-OWNED AND LEASED VEHICLES	15					
DIESEL	16					
ELECTRIC	17					
E-85	18					
GASOLINE	19					
HYDROGEN	20					
MASS	21					
LPG	22					
NO	23					
OTHER	24					
TOTAL	25					
SECTION IV PART B AGENCY-OWNED AND LEASED VEHICLES (Required Only for Fleet Users)	26					
DIESEL	27					
ELECTRIC	28					
E-85	29					
GASOLINE	30					
HYDROGEN	31					
MASS	32					
LPG	33					
NO	34					
OTHER	35					
TOTAL	36					
SECTION IV PART C ANNUAL FUEL CONSUMPTION REPORT BY FUEL TYPE	37					
DIESEL	38					
ELECTRIC	39					
E-85	40					
GASOLINE	41					
HYDROGEN	42					
MASS	43					
LPG	44					
NO	45					
OTHER	46					
TOTAL	47					
FUEL CONVERSION TABLE						
Description		Line No.	GASOLINE EQUIVALENT (GALLONS)	LIQUID FUEL COSTS (GALLONS)	Alternative Fuel	Gasoline Equivalent Gallons (GEG)
Diesel		38			Gasoline	No conversion needed
Electric		39			Gasoline	No conversion needed
E-85		40			Gasoline	No conversion needed
Gasoline		41			Gasoline	No conversion needed
Hydrogen		42			Gasoline	No conversion needed
MASS		43			Gasoline	No conversion needed
LPG		44			Gasoline	No conversion needed
NO		45			Gasoline	No conversion needed
OTHER		46			Gasoline	No conversion needed
TOTAL		47			Gasoline	No conversion needed

Figure 2. SF 82 Agency Report of Motor Vehicle Data (page 2)

lack thereof; in which case, OLVIMS simply disregards the record. Another is that OLVIMS downloads fuel data from the FAS Enterprise Server for vehicle fuel usage. If the DoDAAC/SRAN is incorrect, the data will not flow to OLVIMS for the proper base. To ensure the data contained are correct, Air Force Instruction (AFI), 24-301, *Vehicle Operations*, paragraph, 3.1.1 states:

Vehicle Operations will provide the BFMO a semiannual, or as required, master list depicting all assigned vehicles and organizations codes. A system will be developed between the BFMO and fleet management to ensure notification of vehicle deletions, assignments, and rotations.

At bases with automated fuels service stations, the BFMO collects fuel-consumption data and uploads them to the DESC FAS Enterprise Server. For bases without automated fuels service stations, the fuel data are manually entered into OLVIMS via an MZ transaction. Air Force Computer System Manual (AFCSM) 24-1, *Online Vehicle Interactive Management System, End User Manual*, paragraph 5.3.20.5 states: "MC&A [maintenance control and analysis] will prepare this format to input all transient fuel/oil issues, all on-base fuel/oil issues from fuel points not supported by SBSS." Data flow from DESC to OLVIMS is the same for each of the ways to obtain fuel.

Organizational Bulk-Fuel Tank. The second way to obtain fuel is from an organizational bulk-fuel tank (Figure 6). Bulk-issue tanks are used mainly by organizations to refuel equipment items (lawnmowers and other ground equipment). Units refueling vehicles from the bulk-issue tanks must provide vehicle fuel-consumption data to BFMO using Air Force Form 1994, *Fuel Issue/Defuel Document* (AFI 23-204, paragraph 10). The BFMO then processes defuel (credit) and issue (debit) transactions. This process identifies the quantity and type of fuel and vehicle registration number. These transactions are uploaded, along with other base fuel transactions, to the DESC FAS Enterprise Server. If the fuel-consumption data from the organizational fuel tanks are not provided to the BFMO, then those data are lost.

Commercial Service Stations

Using the DoD Fleet Credit Card at commercial service stations is another way of obtaining fuel (Figure 7). There are two types of credit cards: those with individual embossed registration numbers and generic cards that can be used for any government-owned vehicle. The first one is for organizations with frequent off-base requirements, while the second one is used by vehicle operations to facilitate bulk-fuel issues for occasional, off-base use of government-owned vehicles. DESC is responsible for DoD Fleet Credit Card program management and policy oversight. All fuel-consumption data flow directly from USBank/Voyager (the card issuer) to the DESC FAS Enterprise Server. Fuel-consumption data for specific vehicle registration numbers can be retrieved by OLVIMS without any further action. However, to get fuel-consumption data for generic credit card use, vehicle operations must identify to BFMO, for each separate fueling, the fuel type and quantity, vehicle registration number, and DoDAAC for the card owner and organization that used the vehicle. As with bulk issues, the BFMO processes defuel (credit) transactions for the credit card owner (usually vehicle operations) and issue (debit) transactions (the organization using the card), along with the vehicle registration number. These transactions are required to identify fuel consumption for each vehicle registration number, using the DoD Fleet Credit Card. These transactions are uploaded to DESC, along with other base fuel transactions.

The DoD Fleet Credit Card is not the only way to obtain fuel from commercial service stations. At some overseas locations, fuel coupons are used because the DoD card is not accepted. Vehicle operations purchases the coupons from the Army and Air Force Exchange Service (AAFES) and issues them to drivers when vehicles are dispatched off base. Fuel-consumption data from the coupons are gathered by vehicle operations and passed to vehicle maintenance for manual input into OLVIMS via an MZ transaction.

Description	Direct Cost Data				
	Commercial Lease Cost	Owned Maintenance Cost	Owned Miles Traveled	GSA Lease Cost	GSA Miles Traveled
a	b	C	d	E	f
Sedans & SW	\$	\$		\$	
Ambulances	\$	\$		\$	
Buses	\$	\$		\$	
LD Truck 4x2	\$	\$		\$	
LD Truck 4x4	\$	\$		\$	
MD 8,501-16,000 lbs	\$	\$		\$	
HD over 16,001 lbs	\$	\$		\$	

Figure 3. FAST, Section II

Fuel Type	Cost	Natural Units				GGE				
		GSA Leased	Commercially Leased	Owned		GSA Leased	Commercially Leased	Owned	Total	Conversion Ratio
a	b	c	d	e	f	g	h	i	j	k
B20	\$				gallons					112.6% (gal x 1.126=GGE)
CNG	\$				gallons @ 2400 psi					18% (gal x .18=GGE)
CNG	\$				gallons @ 3000 psi					22.5% (gal x .225=GGE)
CNG	\$				gallons @ 3600 psi					27% (gal x .27=GGE)
CNG	\$				hundred cubic feet					83% (ccf x .83=GGE)
Diesel	\$				gallons					114.7% (gal x 1.147=GGE)
Diesel-Emergency, Special Purpose & Military	\$				gallons					114.7% (gal x 1.147=GGE)
Diesel-Law Enforcement Vehicles	\$				gallons					114.7% (gal x 1.147=GGE)
E-85	\$				gallons					72% (gal x .72=GGE)
Electric	\$				KWH					3% (KWH x .03=GGE)
Gasoline	\$				gallons					No conversion needed
Gasoline-Emergency, Special Purpose & Military	\$				gallons					No conversion needed

Figure 4. FAST, Section III

DESC FAS Enterprise Server or Purple Hub

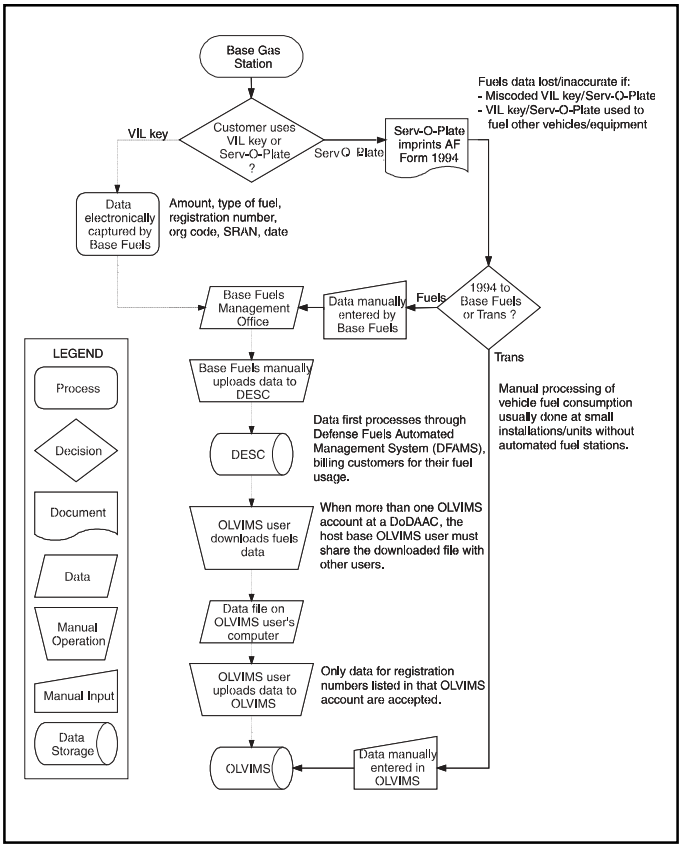
On all three flowcharts (Figures 5, 6, and 7), fuel-consumption data flow to DESC, except the data fed directly into OLVIMS. Prior to 1 October 2001, data flowed from SBSS to OLVIMS. The following is an overview of DESC and explains why fuel data now come from this particular system.

- **FAS** is a vertically integrated, automated information system consisting of base-level components and enterprise-level systems that provide visibility of bulk-fuel assets and transactions to the Services, combatant commanders, vendors, and DESC—meaning the entire fuel process.
- **FAS Enterprise Server Purple Hub** is where the fuels data reside. The Hub collects, routes, and reports transactions among bases, contractors, DESC, the Defense Finance

- **Purple** is a term referring to DoD in general, without reference to any specific Service.

An interface requirement agreement between FAS and OLVIMS was established on 20 February 2001. Vehicle fuel data for government-owned vehicles transferred from SBSS to the DESC FAS Enterprise Server on 1 October 2001. At the time of this writing, only data on fuel purchased through DESC were populated in the OLVIMS transfer file. DESC tracks all conventional petroleum products and some alternative fuels such as biodiesel and ethanol (E-85). For any type of fuel not purchased through DESC, such as compressed natural gas (CNG), the fuel-consumption data are manually input into OLVIMS.

The OLVIMS query and download capability provides the Air Force visibility of fuels obligation data resident in the FAS Enterprise Server. This capability is provided between the FES Web site and OLVIMS end user. The data are managed, operated, and maintained at the FAS Enterprise Server by DESC or its contractors. The FAS Enterprise Server creates an OLVIMS transfer file, making the information available on the FES Web site in the specific file format as defined in the interface agreement. Before the fuel data are released to OLVIMS, they



```
graph TD
    A([Organizational Bulk-Fuel Tank]) --> B[Customer or tank custodian manually fills out log at pump, or AF Form 1994]
    B --> C[/Base Fuels processes  
- Defuel (credit)  
- Issue (debit)/]
    C --> D[/Base Fuels Management Office/]
    D --> E[/Base Fuels manually initiates upload of data to DESC/]
    E --> F([DESC])
    F --> G[/OLVIMS user downloads fuels data/]
    G --> H[/Data file on OLVIMS user's computer/]
    H --> I[/OLVIMS user initiates upload of data to OLVIMS/]
    I --> J([OLVIMS])
```

The flowchart illustrates the process of fuel management, starting from an Organizational Bulk-Fuel Tank. The process involves manual data entry by the customer or tank custodian, followed by Base Fuels processing (defueling or issuing). The data is then manually uploaded to the Defense Fuels Automated Management System (DESC) by the Base Fuels Management Office. The data is first processed through DFAMS for billing. If multiple OLVIMS accounts are involved, the data is shared. Finally, the OLVIMS user uploads the data to the OLVIMS system for automated identification of customer and registration number.

Amount, type of fuel, registration number, date

Customer or tank custodian manually fills out log at pump, or AF Form 1994

Base Fuels processes

- Defuel (credit)
- Issue (debit)

Base Fuels Management Office

Base Fuels manually initiates upload of data to DESC

DESC

OLVIMS user downloads fuels data

Data file on OLVIMS user's computer

OLVIMS user initiates upload of data to OLVIMS

OLVIMS

No automated identification of customer, registration number, etc.

Fuels data lost/inaccurate if:

- Log not filled out or contains errors
- Form not completed, or contains errors
- Form not sent to Base Fuels
- Info not transcribed accurately from log

These processes required to identify fuel consumption for each vehicle registration number.

Data first processes through Defense Fuels Automated Management System (DFAMS), billing customers for their fuel usage

When more than one OLVIMS account at a DoDAAC, the host base OLVIMS user must share the downloaded file with other users.

Only data for registration numbers listed in that OLVIMS account are accepted.

pass through the Defense Fuels Automated Management System, which bills customers for fuel usage.

To access the Purple Hub, each OLVIMS user must establish a user identification and password by filling out Defense Logistics Agency Form 1811. The Hub is available at <https://www.fehub.desc.dla.mil/> (requires Netscape Version 4.76 or higher to view), and procedural guidance is located at <http://www.desc.dla.mil>.

Each vehicle maintenance facility with an OLVIMS capability logs onto the FAS Enterprise Server to obtain its fuel-consumption data. A permit file is created the first time end users log onto FAS. This file establishes the basic information for downloading vehicle fuels data. DESC flags transactions as OLVIMS users download them, ensuring the records are not downloaded twice. Each download is maintained on the DESC server for retrieval for up to 30 days in case the files are lost or corrupted prior to uploading to OLVIMS. If a base has more than one OLVIMS user account (DoDAAC), the first user to log onto FAS gets all available records for that DoDAAC; other users only get subsequent records. Thus, the OLVIMS account managers must establish procedures for sharing the downloaded data.

The following line represents a DESC fuel transaction downloaded by the OLVIMS user, and Table 1 is a breakdown of the data line:

	1	2	3	4
Record position	12345678901234567890123456789012345678901234			
Date line	VIM 01B00119012041324		00000122401BDIGL	

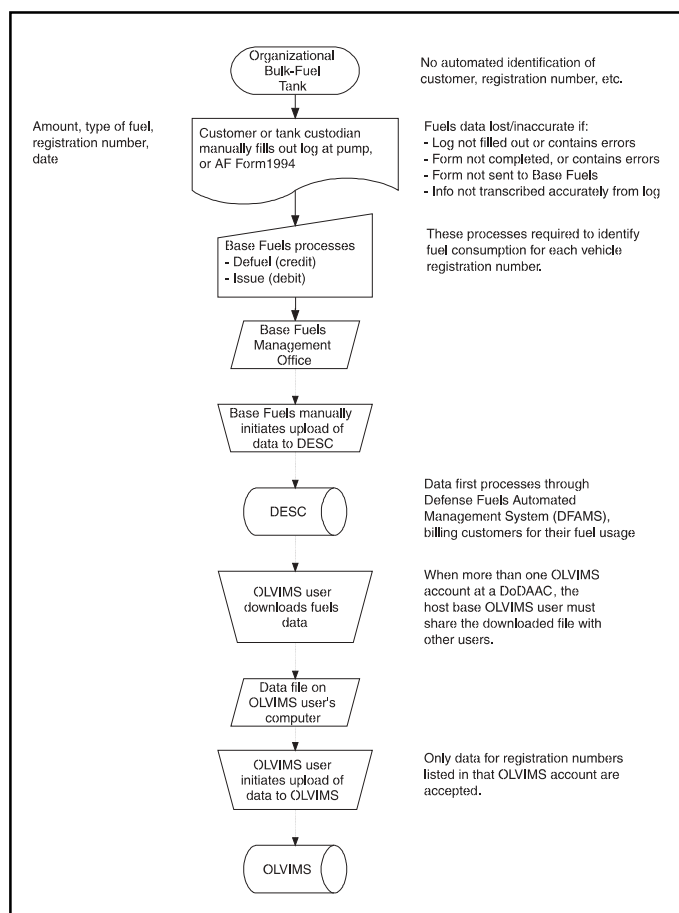


Figure 7. Flowchart for Fuel Data Obtained from Commercial Service Station

OLVIMS

For transportation-specific purposes (base, MAJCOM, and Air Force-wide), fuel-consumption data are captured in OLVIMS. AFCSM 24-1, paragraph 1.2 defines the purpose of OLVIMS:

The purpose of OLVIMS is to provide an online, interactive system of records and files which can be created, accessed, updated, deleted, exercised, and summarized in a real-time manner. OLVIMS will provide online processing with immediate response, which ensures the database is current as of the last update. The user has total control and responsibility for the accuracy of the database, which resides on an authorized microcomputer located within the system users work area. OLVIMS is designed as a base-level management information system that allows upward reporting.

OLVIMS users retrieve fuel-consumption data from DESC via the local area network or Internet and then initiate an upload of the data to OLVIMS. Fuel consumption not processed through FAS (DESC) is manually input into OLVIMS through an MZ transaction. OLVIMS systems are located at installations that have government-owned vehicles. Currently, 360 installations or units operate OLVIMS at 258 geographical locations.

OLVIMS identifies vehicles by their primary fuel types and reports total fuel used; it cannot break out different fuel types and quantities consumed for bi-, flex-, and dual-fueled vehicles (vehicles that can use both petroleum and alternative fuels).

Modernized OLVIMS. Although the next-generation OLVIMS will still be called OLVIMS, it is commonly referred to as modernized OLVIMS and incorporates the following changes:

- Transition to MS Windows environment
- Combination of vehicle operations and maintenance modules to a single database (currently, vehicle maintenance data reside at each installation and are rolled up quarterly to Air Staff)
- Web-based system on the Air Force Global Combat Support Systems (GCSS)
- Modernized programming language
- Additional security features
- Enhanced ad hoc query capabilities
- Compatibility with other tools (Word, Excel)
- Comprehensive online help

The Standard Systems Group (SSG) is working on fielding Increment I to OLVIMS, which encompasses the vehicle operations dispatch module. Increment II is scheduled for release in 2003 and encompasses the fleet management, command fleet management, and vehicle maintenance modules.

The same kind of fuels data captured today will flow to modernized OLVIMS, including alternative fuels (bi-, flex-, and dual-fueled vehicles, such as CNG). OLVIMS will then be able to report the fuel types and quantities for each vehicle. Once Increment II is fielded and testing is completed, SSG and DESC plan to develop an automated, seamless interface of the fuel data from the FAS Enterprise Server to the OLVIMS web database. This will result in more accurate fuel-consumption statistics, without 360 different OLVIMS users pulling data from the FAS Enterprise Server and manually editing and feeding them into OLVIMS. Figure 8 illustrates the current and projected processes.

Constraints will be in place to reduce misuse of the VIL key. OLVIMS will identify fuel amounts that exceed vehicle fuel-tank capacity over a 1-day period, thus identifying vehicle users who abuse the VIL key.

Analysis

An understanding of fuel data collection and flow enables analysis of fuel-consumption data collected in OLVIMS and summation of the data and feedback collected from bases. The objective was to determine if the data were accurate and, if not, how much error was involved. All fuel used by the Air Force in government-owned vehicles should be reported to OLVIMS. The OLVIMS data analyzed were obtained from an Air Force-wide database at AFLMA, which is updated quarterly by files received from WR-ALC. WR-ALC is responsible for collecting the quarterly OLVIMS files. Each quarter, bases forward OLVIMS data files to their MAJCOMs, who in turn consolidate the files and forward them to WR-ALC. WR-ALC then consolidates the MAJCOM files into one data file (CAFVIMS) for input into the Consolidated Analysis and Reporting System.

To verify reporting accuracy, data were reviewed to determine if vehicles were reported with utilization but no fuel consumption or with fuel consumption but no utilization. Three representative vehicle types were then examined to objectively estimate the correct fuel consumption. The results provided a basis for questions to be asked during base visits and for developing a base questionnaire.

OLVIMS Data—Vehicles with Utilization and Zero Fuel Usage. The data analyzed came from FY01 third and fourth quarters and FY02 first quarter. Because base transportation maintains registered vehicles, nonregistered vehicles, and

Name	Type	Record Position	Definition
Transaction Identification Code	Alpha	1 – 3	Always <i>VIM</i> . Ignored by OLVIMS.
Issuing Station	Alphanumeric	4 – 5	The issuing station code. <i>May be blank—this one is</i> . <i>0Y</i> indicates a transient issue. <i>0Z</i> is used for other government agency and commercial purchases. If blank, the system will enter the vehicle's using organization code.
Registration Number	Alphanumeric	6 – 13	The registration number of the vehicle that received fuel or oil processed by FAS. If the registration number is not in the database or the vehicle is coded with an <i>N</i> (no fuel) code, disregard this input and continue with the next input. <i>01B00119</i> is the registration number.
Fuel/Oil Quantity	Numeric	14 – 17	The quantity of fuel or oil purchased. If the product identification is <i>0</i> , <i>1</i> , <i>2</i> , or <i>3</i> , the quantity is oil, and the system will charge as oil. All other product identification is fuel, and the system will charge as fuel. <i>0120</i> is the quantity = 12.0 gallons.
Product ID	Numeric	18	Oil issues will have <i>0 – 3</i> . Others are for fuel. This is <i>4</i> ; it stands for a fuel transaction.
Julian Date	Julian Date	19 – 22	Date issued. This date cannot be greater than system date or in a prior month, unless system is in dual-month status, where it cannot be earlier than first of that month. <i>1324</i> is the Julian date = 19 Nov 01; new system will use the complete date.
Reverse Post Indicator	Alphanumeric	28	Blank or <i>R</i> . If <i>R</i> , reverse the quantity/cost and recalculate affected system areas. This is used for error inputs.
Fuel/Oil Cost	Numeric	29 – 37	Total cost of fuel or oil. <i>000001224</i> = the cost which equals \$12.24.
System Designator	Alphanumeric	38 – 39	Used to identify the fuel or oil issue point as a host or satellite. Ignored by OLVIMS. <i>01</i> designates a host (base transaction).
Grade/Type	Alphanumeric	40 – 42	Identifies the type of fuel issued. If it was an oil purchase, this field will be blank. <i>BDI</i> is the product fuel code—biodiesel.
Unit of Issue	Alpha	43 – 44	Specifies how the fuel or oil was issued; for example, gallons, pounds, and so forth. <i>GL</i> = gallons.

Table 1. Breakdown of DESC Vehicle Fuels Data

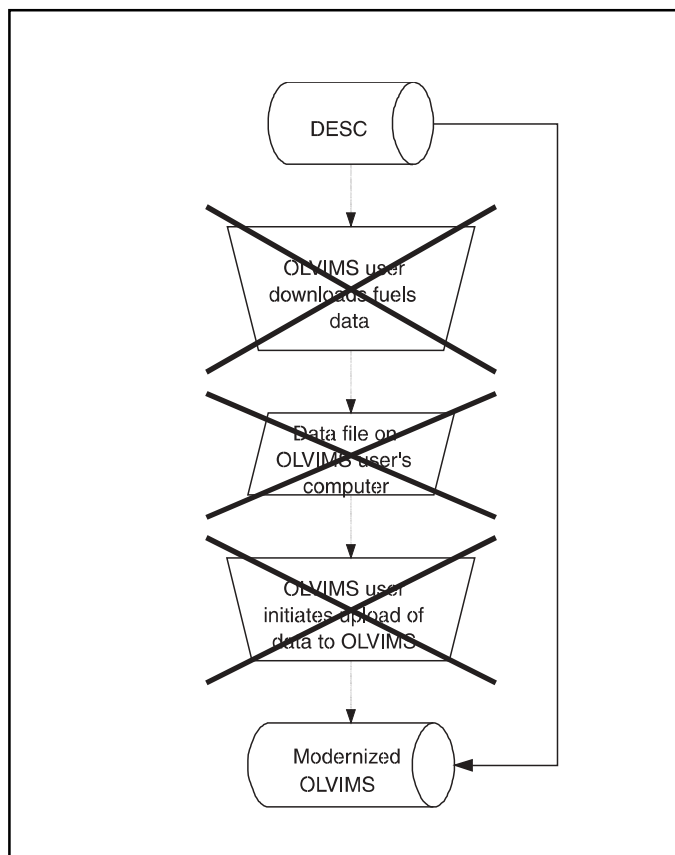


Figure 8. Proposed Data Feed to Modernized OLVIMS

vehicular equipment items, filters were applied to the quarterly data files to extract only the registered vehicle fleet that consumed fuel. Records with the following characteristics were eliminated.

- Registration numbers *W* or *X*
 - *W*—nonregistered
 - *X*—equipment items
- Numeric management codes (equipment items)
- Utilization measurement *U* (unit, no measurement)
- Fuel codes *N* or *V*
 - *N*—nonfuel
 - *V*—electric

Table 2 lists the results of applying the filters by quarter and is broken out by the measure of utilization. It lists the mean (average) utilization from records, median utilization (midpoint), and minimum and maximum reported utilization. This showed that reported utilization ranged from none to impracticably high values. Thus, data had to be further filtered and segmented to exclude possibly erroneous records and vehicles that, logically, would not have used fuel.

From records identified in Table 2, all vehicles with greater than zero reported utilization and zero reported fuel usage. The records were then separated by usage category (miles, hours, or kilometers), and levels of reported usage were selected. The results are displayed in Table 3 and are broken out as follows:

Count # 1—Represents records with any reported *M/H/K* utilization above zero.

Count # 2—*Typical utilization* eliminated low-usage vehicles that might not have required refueling during the quarter (count 3) and records with excessively high utilization data that might be erroneous (count 4). This represents vehicles with reasonable utilization that required refueling at some point during the quarter.

Count # 3—*Low utilization* represents vehicles with little utilization that did not have to refuel during the quarter.

Count # 4—*Excessive utilization* represents highly utilized vehicles with possibly erroneous utilization data.

Figure 9 graphically represents the data in Table 3.

Count #1 in Table 3 indicates approximately 27 percent of the registered fuel-consuming vehicles in the fleet were utilized, but no fuel-consumption data were reported in OLVIMS. It is possible some vehicles did not require refueling during the quarter (war reserve materiel, emergency response, and so forth). They are represented by Count #3, which is about 17 percent of the registered fuel-consuming vehicles. Also, about .4 percent of these reported excessively high utilization, which might be erroneous records. Of concern were the remaining 10 percent with *typical* utilization, which should have had fuel-consumption data reported in OLVIMS during the quarter. These vehicles were identified for the bases to be visited. The information was forwarded prior to the visits to see if they could help determine why the fuel data did not flow to OLVIMS. Results are shown in the base visits section.

OLVIMS Data—Vehicles with Zero Utilization and Reported Fuel Usage

Records were also found with reported fuel consumption but no reported utilization (M/H/K). This was generally only about 1 percent of the registered fuel-consuming fleet, but it indicated

Usage Indicator	Count	%	Mean Utilization	Median Utilization	Minimum Utilization	Maximum Utilization
FY01, 3 ^d Quarter—Total of 94,186 records						
H (hours)	20,639	30	173	21	0	85,627
K (kilometers)	3,497	5	1,667	624	0	92,368
M (miles)	45,657	65	1,104	396	0	99,959
	69,793—Registered vehicles consuming fuel					
FY01, 4 th Quarter—Total of 95,987 records						
H (hours)	21,164	30	161	23	0	90,995
K (kilometers)	3,468	5	1,707	661	0	97,283
M (miles)	46,608	65	1,216	471	0	99,776
	71,240—Registered vehicles consuming fuel					
FY02, 1 st Quarter—Total of 93,804 records						
H (hours)	20,953	31	171	23	0	86,676
K (kilometers)	3,578	5	1,915	750	0	81,733
M (miles)	43,905	64	800	415	0	99,173
	68,436—Registered vehicles consuming fuel					

Table 2. Registered Vehicles Consuming Fuel

Usage Indicator	Count #1	Count # 2		Count # 3		Count # 4	
		Utilization		Utilization		Utilization	
FY01, 3 ^d Quarter—Total of 69,793 records							
H (hours)	6,872	50-1,000	1,982	< 50	4,770	> 1,000	120
K (kilometers)	930	800-16,000	423	< 800	496	> 1,6000	11
M (miles)	11,562	500-10,000	4,172	< 500	7,257	> 10,000	133
	19,364		6,577		12,523		264
Note 1	27.7%		9.4%		17.9%		0.4%
FY01, 4 th Quarter—Total of 71,240 records							
H (hours)	6,596	50-1,000	1,988	< 50	4,491	> 1,000	117
K (kilometers)	948	800-16,000	210	< 800	423	> 16,000	15
M (miles)	11,767	500-10,000	4712	< 500	6,914	> 10,000	147
	19,311		7,210		11,828		273
Note 1	27.1%		10.1%		16.6%		0.4%
FY02, 1 st Quarter—Total of 68,436 records							
H (hours)	6,807	50-1,000	2,183	< 50	4,504	> 1,000	120
K (kilometers)	1,105	800-16,000	605	< 800	486	> 16,000	14
M (miles)	11,513	500-10,000	4,798	< 500	6,574	> 10,000	141
	19,425		7,586		11,564		275
Note 1	28.4%		11.1%		16.9%		0.4%
Note 1. Represents the percentage of vehicles being analyzed							

Table 3. Registered Vehicles with Utilization and Zero Fuel Consumption

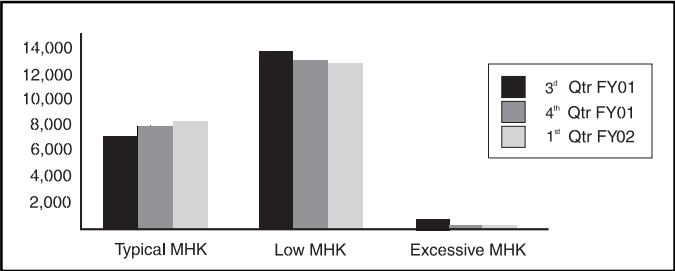


Figure 9. Graphical View of Data in Table 3

fuel was reported against the wrong vehicle or reported utilization may have been inaccurate. For example, FY01 third quarter data showed 50 records with at least 100 gallons of reported fuel consumption but no reported utilization. The most extreme case reported 852 gallons of fuel pumped during that particular quarter.

The results from these two analyses indicate erroneous fuel-consumption data in OLVIMS; the fuel was either not reported or was reported against a vehicle that was different from the one that actually used the fuel. However, since reported utilization can also be in error, there was no way to judge, from vehicle to vehicle, whether or not the reported fuel consumption was reasonable and accurate. In the next section, several different methods are used to estimate the amount of fuel consumed for an entire fleet. Of course, this approach ultimately depends on the accuracy of the reported utilization.

OLVIMS Data—Objectively Estimate Actual Fuel Consumption. The next step in the analysis was to look at reported fuel consumption to determine objectively what should have been reported based on records with apparently reasonable utilization and fuel consumption. About 10 percent of the vehicle fleet had usage that should have required refueling, even though nothing was reported. We looked at ways of estimating average fuel economy (miles, kilometers, or hours per gallon) for a given vehicle type and then, assuming fairly consistent fuel economy within a vehicle type and reasonable utilization data, used the average fuel economy to estimate how much fuel was actually consumed. Because of differences in fuel economy averages among vehicle types, it was necessary to analyze each type separately, which required both automated and manual analysis. The records analyzed came from FY01 annual OLVIMS data comprised of about 75,500 vehicles, which represented 430 different vehicle types. It was not feasible to analyze each vehicle type separately. Three vehicle types were analyzed for this project: truck 6 passenger pickup 4X2 (6PAX), truck compact

Year Model	Ford Ranger (city/highway)	Chevrolet S10 (city/highway)	Dodge Ram 50 (city/highway)
1985	21/24	21/27	23/24
1986	21/26	21/28	22/24
1987	21/26	21/23	23/27
1988	22/27	21/28	23/26
1989	20/24	21/28	23/26
1990	*	21/27	19/23
1991	21/23	21/28	19/23
1992	20/23	20/26	19/23
1993	21/24	20/26	19/23
1994	21/24	19/25	*
1995	21/25	20/26	*
1996	20/25	20/27	*
1997	21/25	20/27	*
1998	20/25	19/26	*
1999	20/25	19/26	*
2000	20/25	19/26	*
2001	20/24	*	*
* Four-cylinder not available Average for city/highway for above numbers 20.6/25.3			

Table 4. DoE Fuel-Economy Averages

	6PAX	CMPT PU	Bobtail
Raw Data (# / M/HPG)	2125 / 17.55	4240 / 23.38	3167 / 8.72
Remove Bad Records (# / M/HPG)	2077 / 17.01	4214 / 22.90	2923 / 3.97
20-80% (# / HPG)	1009 / 13.47	1757 / 19.88	1351 / 1.84
Estimated¹ (# / HPG)	12.5	18.0	1.65
¹ Estimated range (cluster) determined by author			

Table 5. Comparison of Raw Data to Estimated Data

pickup 4X2 (CMPT PU), and flight-line aerospace-ground equipment tow tractor (Bobtail). The quantities of each vehicle type are among the largest in the Air Force fleet. The Bobtail was selected because of the assumption that vehicles operating on the flight line refuel from organizational bulk-issue fuel tanks located near or on the flight line. This might be one reason fuel consumption was not always reported to OLVIMS.

Average utilization per gallon was analyzed based on a building-block approach; the first step was to look at the raw data and move to records with credible utilization and fuel consumption. The following explains each step, and Table 5 consolidates the data for comparison.

Raw data—with no filters, the data from OLVIMS were as follows:

	6 PAX	CMPT PU	Bobtail
Number of records	2,125	4,240	3,167
Utilization¹	13,772,142	18,364,502	4,583,660
Fuel consumption (gal)	784,774	785,548	525,885
Average M/HPG	17.55	23.38	8.72

¹6PAX and CMPT PU utilization is in miles and Bobtail in hours.

Bad records—filters out records where reported miles or hours for FY01 were greater than reported lifetime miles or hours. This eliminated 48 6PAX, 26 CMPT PU, and 244 Bobtail records.

	6 PAX	CMPT PU	Bobtail
Number of records	2,077	4,214	2,923
Utilization¹	12,627,720	17,810,332	1,788,858
Fuel consumption (gal)	742,329	777,616	450,628
Average M/HPG	17.01	22.90	3.97

¹6PAX and CMPT PU utilization is in miles and Bobtail in hours.

20-80 Percent—additional filters were applied to the above records to eliminate records affecting average miles or hours per gallon. Filtered out were records with zero utilization or zero fuel consumption. This eliminated records with zero utilization with fuel reported and positive utilization with zero fuel consumption. Also, only records with the fuel-use code (indicating either diesel or gasoline) and with usage as miles for the CPMT PU and 6PAX or hours for the Bobtail were retained. After these filters were established, the 20-to-80-percentile filter was applied, eliminating records with a utilization less than 20 percent and more than 80 percent of all reported values. The final records represent vehicles with reasonable utilization and fuel consumption reported in OLVIMS.

	6 PAX	CMPT PU	Bobtail
Number of records	1,009	1,757	1,351
Utilization ¹	4,851,405	6,080,291	441,594
Fuel consumption (gal)	360,273	305,825	239,697
Average M/HPG	13.47	19.88	1.84

¹6PAX and CMPT PU utilization is in miles and Bobtail in hours.

Using the above records, particularly the CMPT PU, the average miles per gallon were compared to data contained on the DoE fuel-economy guide Web page. The fuel economy estimates (city and highway miles per gallon) are based on results of tests required by the US Environmental Protection Agency. DoE does not perform these tests on the heavier pickup models represented by the 6PAX, so no fuel-economy results were available for comparison to the OLVIMS results. These tests are used to certify that vehicles meet federal emissions and fuel-economy standards. The Air Force inventory of CMPT PU-year models ranges from 1982 to 2001 and is composed of Ford Rangers, Chevrolet S10s, and Dodge Ram 50s. The Air Force procures these vehicles through GSA as standard item number 60, a standard compact pickup truck. They are equipped with four-cylinder engines and automatic transmissions. Fuel-economy data from DoE are presented in Table 4 for model years 1985 through 2001 (no data were available prior to 1985).

Comparing the CMPT PU data to the DoE averages shows the filtered results obtained from the 20-to-80-percent data were reflective of the DoE city average miles per gallon (usage of the Air Force compact pickups is typical of city driving). DoE average city miles per gallon is 20.6, and the results of the 20-to-80-percent miles per gallon are 19.9.

Estimated—The average miles or hours per gallon from the 20-to-80-percent data are based on an objective look that attempted to eliminate bad records. A subjective approach (authors' view) was also taken, based on the distribution of the M/HPG values for the three vehicle types. A bar graph was created for the individual miles or hours per gallon for records falling within the 20-80 percentiles of the reported M/HPG values and for records from the 20-80 percentile of the utilization values described earlier (Figures 10-12). These percentile ranges were used to eliminate extreme and possibly erroneous values from final consideration. From graphs for each vehicle type, the greatest grouping of miles or hours per gallon decreased and showed an average M/HPG value from that range of values.

Table 5 brings the raw OLVIMS data together with estimated data for comparison. For each vehicle type, the average miles or hours per gallon decreased as expected, based on earlier results where data indicated about 10 percent of the fleet reported utilization but no fuel consumption. The percentage of decrease varied for each vehicle type. From the raw data to the 20-80 percent, miles per gallon for the 6PAX decreased 23 percent, CMPT PU 15 percent, and the hours per gallon for the Bobtail decreased 79 percent. As stated earlier, the Bobtail was selected because it was assumed to be refueling from organizational bulk-fuel tanks and consumption data were not always reported to the BFMO. This assumption was supported by the large decrease in average hours per gallon when potentially erroneous records and zero-reported, fuel-consumption records were eliminated. Note also, for the Bobtail, the effect that erroneous usage data can have on estimated fuel economy (the change in fuel economy when the 244 records with annual usage greater than lifetime usage are removed).

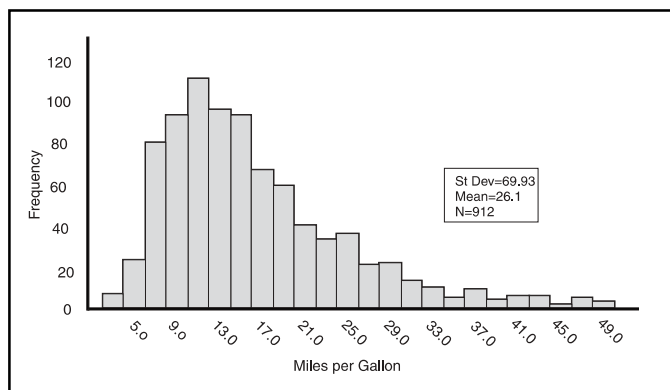


Figure 10. 20-80 Percent Miles Per Gallon for 6PAX

Estimated miles per gallon are 12.5 as taken from the cluster of records between 6 and 16 miles per gallon.

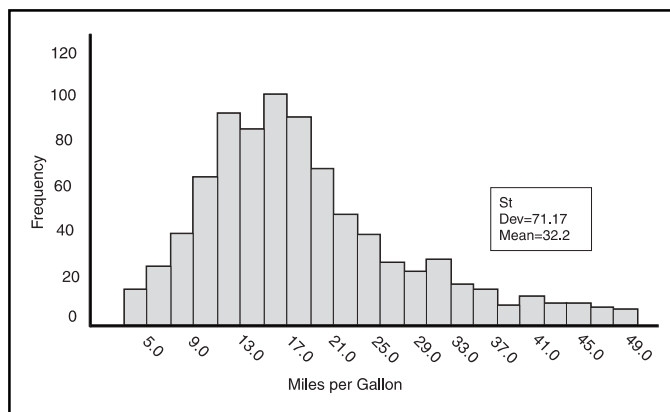


Figure 11. 20-80 Percent Miles Per Gallon for CMPT PU

Estimated miles per gallon are 18 as taken from the cluster of records between 12 and 24 miles per gallon.

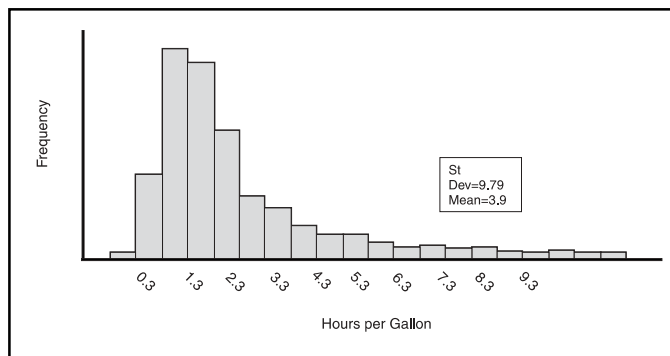


Figure 12. 20-80 Percent Hours Per Gallon for Bobtail

Estimated hours per gallon are 1.65 as taken from the cluster of records between 1.3 and 2.3 hours per gallon.

In summary, the analysis indicated fuel consumption was most likely under-reported. Table 6 shows this by displaying the utilization and total gallons reported in OLVIMS (using raw data minus the bad records) and what might have been reported using the average M/HPG results from the 20-80 percent. The results in Table 6 are based on the assumption that utilization was reported accurately for the records considered.

The point of contact for the study asked if fuel consumption could be estimated for previous years so the Air Force could

establish a baseline value. The baseline value could be used to estimate reductions in consumption of petroleum-based fuels and increases in usage of alternative fuels to meet EPAct and Executive order mandates. While the capability to estimate fuel consumption exists, it is critically dependent on the accuracy of the data reported. Even when using data filters to select the most accurate records for making estimates of fuel economy, the estimate of consumption is still dependent on the accuracy of the reported vehicle usage. In Table 6, consumption was estimated for vehicles that did not have the most obvious utilization error, reporting more annual utilization than lifetime utilization. Obviously, these vehicles used fuel, but what annual mileage (or hours) should be attributed to them to estimate fuel utilization? A second drawback is applying the overall average fuel economy estimate to all vehicles, regardless of age or operating conditions. Thus, while one could spend time making an estimate for each vehicle type (and some have very few records from which to estimate), the result could be easily challenged.

Base Visits. The base visits provided quantifiable data about where in the process the data were lost. Bases visited were Maxwell AFB, Alabama; Tyndall AFB, Eglin AFB, and Hurlburt Field, Florida; Andrews AFB, Maryland; Langley AFB, Virginia; and Peterson AFB, Colorado. The visits focused on three main issues: vehicles with typical miles but no fuel consumption, off-base fuel purchases using the DoD Fleet Credit Card, and suspect fuel data.

Vehicles with Typical Miles and No Fuel Consumption

Vehicles with typical miles but no fuel consumption were identified to the bases prior to visiting them. Transportation personnel coordinated with the vehicle users and BFMO to determine the causes of the incorrect records. Below is one base's response.

From FY01 third and fourth quarter data, the 120 vehicles accumulated typical miles but reflected no fuel consumption because:

86 vehicles were using bulk-fuel tanks, 18 vehicles were using VIL keys from other vehicles, 5 vehicles were using improperly coded VIL keys, and 11 vehicles for miscellaneous reasons (could not determine specific cause).

The following identify why the fuel-consumption data did not flow to OLVIMS:

- VIL Key.**

Vehicles were refueled with VIL keys belonging to other vehicles, nonregistered vehicles, or equipment items. One base did a comparison of BFMO VIL key listing with the list of vehicles provided showing utilization and zero fuel consumption. Of the 93 vehicles identified, the BFMO listing showed only 24 having been issued a VIL key. AFI 24-301 directs a system be developed to ensure notification of vehicle deletions, assignments, and rotations to BFMO, so VIL keys can be updated, changed, and deleted.

Transportation personnel provided the following suggestions for managing and controlling VIL key usage:

- Set a maximum allowable fuel quantity per VIL key for a 24-hour period. This would decrease use of one VIL key to refuel several vehicles.
- Establish vehicle identification number on the VIL key (number could be the same as the last five digits of the registration number). This would prevent a found key's being used.
- Automate a semiannual reconciliation of assigned vehicles with BFMO's VIL key listing. This would help ensure assigned vehicles have a VIL key and coding is correct.
- **Refueling from organizational bulk-fuel tanks.**

Refueling vehicles from organizational bulk-fuel tanks is allowed, but units are required to report issues to the BFMO. Transportation personnel at five of the seven bases visited were aware of units' refueling vehicles from bulk-fuel tanks, but none was aware of the requirement for the units to report vehicle fuel usage from the tanks.

- **Fuel data were not retrieved from the DESC FAS Enterprise Server.**

Two of the bases visited had not retrieved their data from the FAS Enterprise Server during the period the data were transferred from SBSS to DESC. BFMOs transferred the fuel-transaction accounting to DESC between May and October 2001. When the transfer took place, there was a lack of communication informing transportation units of the system transfer. By the time transportation units were aware of the system transfer and because of the time involved in obtaining a user identification and password, the data were not retrievable for the previous quarters.

Another problem can occur with two or more OLVIMS systems on the same installation; fuel-consumption data can be lost when correct procedures are not followed. The DoDAAC identifies each installation's fuel data. For example, a host OLVIMS user downloads the files and does not provide a copy to tenant OLVIMS users. Personnel at three of the bases visited were not aware of procedures to use when more than one system share the same DoDAAC. Of the three bases, only one had the interim procedures issued by SSG for downloading fuel data from DESC.

All independent organizations (main base, RED HORSE, Guard) on a single base or falling under the control of a base will use the same DoDAAC (FPnnnn, and so forth) and will share the FES file

	6PAX	CMPT PU	Bobtail
Actual Reported¹			
Miles/hours	12,627,720	17,810,332	1,788,858
Fuel consumption (gal)	742,329	777,616	455,062
20-80%			
Actual miles/hours	12,627,720	17,810,332	1,788,858
Avg M/HPG	13.47	19.88	1.84
Estimated fuel consumption (gal)	937,470	895,891	972,205
¹ Raw OLVIMS records minus bad records where reported. Miles/hours were greater than lifetime miles/hours.			

Table 6. Comparison of Fuel-Consumption Reporting

created. This is because the FAS Enterprise Server does not distinguish between the organizations as the SBSS did.

Off-Base Fuel Purchases Using DoD Fleet Credit Card

The second major issue was commercial fuel purchases made with the DoD Fleet Credit Card. As base fuels transferred fuel data from SBSS to DESC, the automated flow of data for commercial purchases stopped. DESC has since implemented new procedures that allow populating the OLVIMS file with off-base purchase data beginning in the FY02 third quarter.

Procedures call for vehicle operations to provide MC&A a copy of the commercial receipts for processing. However, three of the bases visited indicated they had not forwarded copies of the receipts anywhere and had only processed them for payment. At the other four bases, MC&A had received copies of the receipts; three of the four bases were holding the receipts until processing into OLVIMS was completed (as explained in AFCSM 24-1, paragraph 5.3.20 b.(2)). Bases were not aware the flow of data for DoD Fleet Credit Card sales (commercial receipts) had been severed during the switchover to the DESC FAS Enterprise Server. One base had input the transactions into OLVIMS manually using the *MZ* transaction screen; however, it did not enter *OZ* as the *issuing station*, which enables the data to be processed to the off-base database.

Suspect Fuel Data. Bases were asked if procedures were in place to check for suspect fuel data (for example, a standard pickup truck showing 80 miles per gallon). Six bases indicated they checked one or more of the following—monthly PCN 32 reports, quarterly PCN 56 reports, input transactions PCN 5—and reviewed the data during annual staff assistance visits. One base indicated it was not in the fuel data-policing business and did not review fuel-related data.

Alternative Fuel. Data collection at bases dispensing alternative fuel was another issue. Discussions were categorized by fuel type:

- Compressed natural gas:
 - Eglin AFB—station just built, establishing-data collection procedures.
 - Andrews AFB—BFMO provides hard copy of data.
 - Langley AFB—data provided electronically.
 - Peterson AFB—hard copy of data provided by commercial vendor.
Because DESC is not the procurement agency for CNG, it does not flow the data. Each base that uses CNG fuel stations has established its own *county option* for data collection from a local utility company where the CNG is obtained. The Air Force fuels community is currently engaged in developing CNG procurement and transaction accounting procedures that will flow consumption data electronically to OLVIMS.
- Biodiesel:
 - Peterson AFB—consumption data flow electronically from DESC.
 - E-85—ethanol fuel (85 percent ethanol and 15 percent gasoline).
 - Peterson AFB—consumption data flow electronically from DESC.

Alternative fuel is tracked manually in OLVIMS because of the inability to break down consumption for each fuel type consumed in bi-, flex-, and dual-fueled vehicles. Modernized OLVIMS will eliminate this manual tracking process.

Base Questionnaires. Eighty-five percent of the bases surveyed indicated they review for suspect data by checking one or more of the following: monthly PCN 32 reports, quarterly PCN 56 reports, input transactions PCN 5. The data are reviewed during the annual staff assistance visits. Thirty-seven percent of those that indicated they review for suspect data provided additional information indicating they coordinate with unit personnel for corrective action.

They were asked what their total off-base commercial fuel consumption was. Base responses totaled 45,930 gallons while OLVIMS only reported 6,167 gallons. The difference in actual usage from that reported in OLVIMS is mainly attributed to the interruption in the automated flow of these data with the transfer to DESC’s FAS Enterprise Server.

One hundred and four bases reported having no alternative-fueled vehicles. For those 24 bases with alternative-fueled vehicles, collection of the data mirrors the discussion from the base visits. For fuel procured by DESC (contracted), the data flow from the BFMO to DESC, and OLVIMS users retrieve from DESC. CNG fuel data collection was split about 50/50 between being manually or electronically captured.

Another alternative fuel not usually considered is electricity. Few comments identified that electric-charging stations have no meters to track the electric kilowatt-hour being consumed.

With regard to GSA reporting of alternative fuel usage, bases were asked if they could obtain reports from GSA that break out alternative-fuel consumption for bi-, flex-, and dual-fueled vehicles. Responses were similar to the discussion of the GSA visit.

To see how many users were downloading fuel data from DESC, we asked if the petroleum fuels data for OLVIMS pulled from the FAS Enterprise Server or SBSS. The flow of fuel data switched over on 1 October 2001, and the questionnaire was sent out January 2002. Responses were as follows:

Number of Bases	Response
107	FAS Enterprise Server
6	SBSS
6	Unable to access or download data from FAS Enterprise Server
3	Waiting for FAS user identification and password
6	No (to FES or SBSS?)
9	Yes (to FES or SBSS?)
5	NA (no explanation as to how data are received)
16	Manually inputting data in OLVIMS

One base provided the following comment: “SBSS is used at this location; unable to use the FES system due to lack of training.”

Seventy-four bases provided comments to help improve reporting of vehicle fuel data. The two most common comments were:

- Long lead time to establish DESC user identification and password and use Netscape in order to access DESC’s Purple

Hub. (Some base computer managers were not aware that Netscape is a DoD authorized program.)

- VIL key abuses and misuses.

General Services Administration. In FY01, the Air Force leased 13,530 vehicles from GSA. These vehicles, as well as the government-owned vehicles, must meet EPAct and 13149 EO requirements. The leasing costs for GSA vehicle contracts include maintenance and fuel costs; the fleets use a GSA credit card for commercial vendor services. GSA provides basic fleet services, including motor vehicles and replacements, maintenance and repairs, fuel, and vehicle asset management and asset management accounts for consumed fuel (including alternative fuels). However, getting alternative-fuel data from the commercial vendor to GSA is a problem.

The problem of accurate alternative-fuel data lies with product codes not being standardized among suppliers of alternative fuels (ethanol or E-85). Because the product code is not uniform, the data get lost during the billing process from the commercial vendor to GSA. As the billing data are passed from commercial vendors to the GSA billing office, the alternative-fuel-type code is usually changed to reflect regular unleaded fuel. The GSA representatives were involved in tracking the alternative fuel for the assigned vehicle. They purchased E-85 fuel for their assigned vehicle. The receipt reflected the fuel type as E-85; but when they checked the GSA data 2 days later, it reflected they had purchased regular unleaded gasoline. The processors (from one electronic system to another) were not programmed to allow the product type code (E-85 alternative fuel) to flow to the next system in the billing process (Figure 13).

Reporting data for CNG poses even greater challenges than E-85 does. CNG is usually purchased from local utility companies, which use different processes. One major problem is caused by local utility CNG stations issuing their own credit cards since their electronic systems are not programmed to accept the GSA card; CNG usage data do not usually flow electronically to GSA for billing. As with the Air Force, GSA depends heavily on

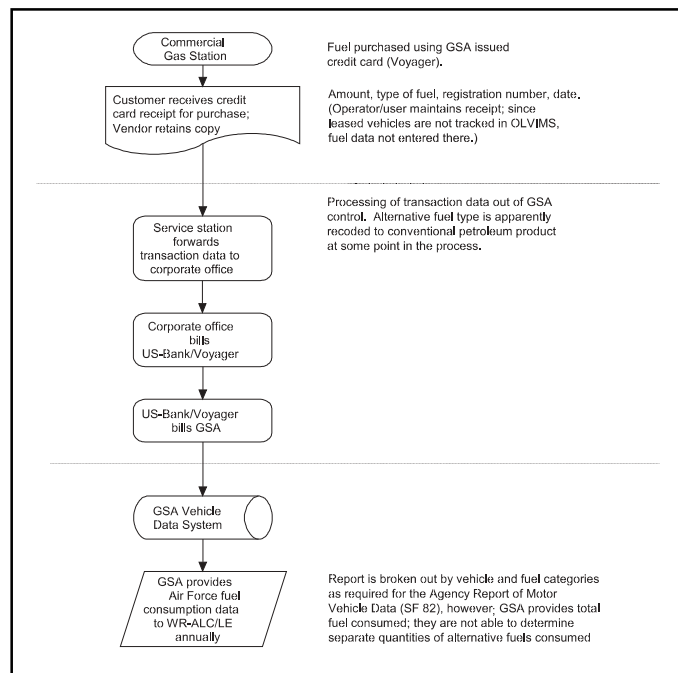


Figure 13. Flow of GSA Fuel Data

electronic data to populate its databases. In addition, CNG is measured in several different ways, including gallons at 2,400 pounds per square inch (psi), 3,000 psi, and 3,600 psi. These require computation of different conversion factors to allow data to be reported as gasoline-gallon equivalents.

Because there is no standard for alternative-fuel coding, GSA recommended each base work with its fleet manager to resolve problems. Together, the base points of contact and GSA can work with alternative-fuel commercial vendors to flow the electronic data and find out where the alternative-fuel-type information is being lost or changed. However, this requires individual action on the part of each base, rather than a resolution for all users.

Vehicle Fuel-Consumption Reporting— Air Force Regulatory Guidance

This section lists Air Force policies reviewed while conducting the analysis. Current policy guidance still reflects data flow from SBSS rather than DESC. The Air Force Logistics Readiness Infrastructure and Vehicles Division and the Materiel Management Policy Division are aware of the requirement to update policy and, prior to DESC implementation, had fielded interim policies to ensure OLVIMS users had guidance until final updates to the policies were completed. Also, the analysis contained herein was begun 1 month after the data flow changed from SBSS to DESC.

AFMAN 23-110, Volume 1, Part 3, USAF Supply Manual

Paragraph 1.78—Vehicle Serv-O-Plates, Ground Fuel Credit Cards, and Vehicle Identification Links (VIL).

Paragraph 1.82—Issues at Non-Air Force Locations—Ground Fuels.

Fuel purchases made with the DoD Fleet credit card are now processed through DESC.

Attachment 34D-4—Manual Fuels Issue/Defuel (1RD/1DF) Screens 1RF/#106, 1DF/#107.

This process is now done through DESC, not through an SBSS transaction.

Attachment 34D-8—Ground Fuel Commercial Issues (1GC) (Screen #356). SBSS transaction to record ground fuel issues to vehicles serviced by commercial vendors.

Appendix D identifies procedures to record fuel purchases from commercial vendors via the DoD Fleet Credit Card.

AFI 23-204, Organizational Fuel Tanks

Paragraph 10—How to Record Fuel Issues.

The process is current; however, terms need to reflect DESC rather than SBSS.

AFCSM 24-1, Transportation Online Vehicle Interactive Management System (OLVIMS): O009/VQ End User Manual

Paragraph 2.1.1.4.8—Fuel/Oil Issues to OLVIMS.

Information reflects data flow from SBSS rather than DESC.

Section “b” states fuel issue “not processed through SBSS” should reflect DESC. Fuel issues from other Air Force installations using the VIL key will flow from DESC to OLVIMS. The SF 149 is no longer used for commercial fuel purchases. The information needs to reflect the DoD Fleet Credit Card.

Paragraph 2.3.6—Loading Base Supply Floppy Disks.

Fuels data now from DESC.

Paragraph 2.3.7—Processing/Files Maintenance.

Fuels data now from DESC.

Paragraph 5.3.20—Fuel/Oil Issues, M.

Most subsections reflect data flow from SBSS rather than DESC (5.3.20 through 5.3.20.6)

Section “b.(2)” requires update to reflect procedures established by DESC

Section “b.(3)” needs to state that organizational bulk-fuel issue data should be processed through BFMO for processing to OLVIMS (AFI 23-204, para 10).

Section “b.(5)” SF 149, replaced by DoD Fleet Credit Card.

AFI 24-301, Vehicle Operations

Paragraph 3.1.1—Supports Air Force Form 1252/1252A, USAF Vehicle Serv-O-Plate and Vehicle Identification Link (VIL).

Paragraph 3.1.8 through 3.1.8.5—Manages the DoD Fleet Credit Card System.

Instructions are required under paragraph 3.1.8.3, “Administering the Fleet Credit Card,” to provide BFMO information. This information is required to update DoD Fleet Credit Card fuel-consumption data. It is also used to charge the organization for fuel usage and, most important, to identify the vehicle registration number. Only after the registration number is added will OLVIMS be able to capture off-base fuel purchases.

Modernized OLVIMS has a menu designed for the DoD Fleet Credit Card. Its purpose is to allow input of commercial fuel receipts so that billing and usage can be tracked. A hard copy document reflecting the information can be printed (Figure 14). However, the data contained on the printed document were required for an “IGC” SBSS transaction that flowed to OLVIMS through daily transactions.

Update section 3.1.8.3.7, which currently reads “Forward a copy of all delivery tickets to Maintenance Control & Analysis (MC&A) weekly for processing.” Courtesy copies of the receipts should be provided to MC&A to monitor the flow of data from DESC to OLVIMS. If fuel-consumption data are from a source not controlled by DESC (for example, fuel coupons purchased through AAFES), the data should be manually processed in OLVIMS.

Overseas purchases using AAFES coupons are few, and the data recording these purchases do not flow through DESC. One base acknowledged it had not provided consumption data from these receipts to MC&A for manual processing.

Instructions are required to ensure MC&A is provided a copy of all non-DoD Fleet Credit Card receipts so that the data can manually input into OLVIMS.

AFMAN 24-307, Procedures for Vehicle Maintenance Management

Paragraph 2.24—Areas to Monitor.

Conclusions and Recommendations

Summary

From the requirements for vehicle fuel-consumption reporting to Air Force regulations that provide guidance on reporting, the complexity of vehicle fuel-consumption reporting is apparent. Public law requires federal agencies to provide this information. Annual reports provide indicators that mark where the Air Force stands on achieving the required 20-percent petroleum, fuel-consumption reduction and use of alternative fuels. Fuel-consumption expenditures are also included in the total operating and maintenance cost for each vehicle. The data are then fed into a vehicle replacement model, which is used to determine vehicle life expectancies and assist with vehicle procurement decisions.

FUEL USAGE			
26MAR2002			
INCLUSIVE DATES: 26FEB2002 TO 26MAR2002			
DATE I			
NPOT:	19MAR2002	TRIC	1GC
DATE PAID:		ISSUE PART-NO	0Z
PURCHASE CHARGED TO FY:		BFMO DODAAC	FZ5612
QUARTER:		CUSTOMER ID	0A
COMPANY:	BP	TID	1
RECEIPT NUMBER:	101	ITEM DESC	
PURCHASE DATE:	19MAR2002		
COST:	\$12.00		
FUEL GRADE:	GUM		
GALLONS:	10		
FUEL ACCT CODE:	0		
VEHICLE REG:	89B00101		

Figure 14. Modernized OLVIMS Output for Commercial Fuel Purchases

Limited fuel data were not being reported to OLVIMS, but procedures and systems were in place. Policies need to be updated, widely disseminated, and adhered to. The release of modernized OLVIMS will eliminate manual tracking of data and greatly enhance vehicle fuel-reporting requirements. So how do we achieve accurate and adequate reporting of fuel-consumption data? The best answer was in comments received from the field.

- 192^d Fighter Wing, Byrd Field, Virginia—“If you do analysis on your fleet using the PCNs provided, you should be able to keep a handle on fuel consumption.”
- 137th Airlift Wing, Will Rogers World Airport—“Accurate reporting of fuel data has always been a problem. The best we have been able to do this is to educate everyone on the importance of accurate reporting and correct problems as they are discovered.”
- Spangdahlem Air Base, Germany—“Educating the users on VIL usage is key.”

OLVIMS provides reports that will indicate suspect fuel consumption. By using the PCN reports and working with the BFMO and vehicle users, problems can be corrected, and vehicle users can be educated to prevent reoccurrence.

Conclusions

The results of the analysis indicate fuel consumption is under-reported in OLVIMS, which is not attributed to the system but to the bad or incomplete data fed into it.

Causes of under-reporting of vehicle fuel consumption include the following:

- VIL keys were encoded incorrectly, and operators were not using the VIL key assigned to the vehicle.
- Operators and unit tank custodians were not reporting individual vehicle fuel consumption from organizational bulk-fuel tanks to the BFMO.
- Fuel data were not retrieved from DESC; some OLVIMS users were unaware of exactly when fuel data moved from SBSS to DESC. Consumption data were lost for quarters preceding the establishment of user IDs and passwords for DESC.
- Data for off-base commercial fuel purchases made with DoD Fleet Credit Cards did not flow electronically to OLVIMS with the changeover from SBSS to DESC. DESC has established new procedures, and the electronic flow should be reestablished in the third quarter of FY02.

Modernized OLVIMS will offer improved methodology for tracking vehicle fuel consumption. Once fielded, modernized OLVIMS will offer the following improvements:

- As a Web-based system on GCSS, OLVIMS will have a new interface agreement with DESC to feed fuel-consumption data directly to OLVIMS. Currently, 258 OLVIMS users must retrieve and upload their data individually.
- Alternative fuel-consumption data for bi-, flex-, and dual-fueled vehicles will be tracked.
- Constraints will be in place to reduce misuse of VIL keys. OLVIMS will identify fuel amounts that exceed vehicle fuel-tank capacity over a 1-day period, thus identifying vehicle users who abuse their VIL keys.
- Current written formal policy still reflects vehicle fuel data flow from SBSS versus the DESC FAS Enterprise Server.

Because GSA only provided an explanation of why alternative-fuel data are not being captured, no determination could be made concerning the accuracy of fuel data for its vehicles.

Recommendations

- Require OLVIMS end users to conduct quarterly analysis of fuel data to check for suspect data.

- Establish VIL key management procedures to prevent misuses.
- Incorporate vehicle *fuel consumption reporting* as an inspection item during inspector general visits.
- Ensure written policy on fuel data flow from DESC is clear and specific.
- Until vehicle fuel data can be fed directly from DESC to OLVIMS, DESC should provide a quarterly report to the Air Force Logistics Readiness Directorate of vehicle fuel transactions not downloaded by base transportation organizations.
- Ensure Standard Systems Group's OLVIMS program managers are consulted whenever procedural changes or updates occur with vehicle fuel data.

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(Isolated Mission continued from page 13))

far, to our knowledge, are around 600 x 600 x 500 mm³. The main dimensional limitations come from the volume of the supply tank, as well as the methods used. Other methods (powder to solid) use thermal processes instead of photochemical ones and use all kinds of materials. Cutting and laminating methods are the only ones that do not rely on a change of state: sheets (paper, plastic) are cut, piled, and glued together. As to the required energy budget, a brief review of the available tools indicates that 500W should be more than sufficient (nothing compared to classical techniques). The tooling required should not take more than 1 or 2m³. The overall mass of raw material needed will depend on the range of the candidate elements. Note that these data are for machines not optimized for space applications.

The main difficulties and drawbacks to these methods are the quality of the obtained parts. For example, only specific resins can be used, and objects obtained through thermal techniques are porous and must be postprocessed. It is clear that the quality levels as to dimensions, geometry, surface, and mechanical characteristics are not yet up to the values one would like to see for direct use of such a part in a real system. However, it seems possible to realize mechanical elements, made from equivalent materials, that respect the functional roles of the original element. Joint improvements of processes and raw materials allowed further manufacture of metallic elements with process times divided by factors up to 20 from the classical manufacturing process. By way of a specific powder, it is possible to produce directly metallic elements from CAD (Figure 3). Reproduction of precise detail and a postprocessing free method, as well as the good mechanical characteristics, allowed use of directly obtained parts.

In this DirectTool™, magnesium parts have been injected. The interest for maintenance is clearly linked with the capability of such technologies to provide a part almost on demand. This suggests that it is possible to use rapid-prototyping techniques

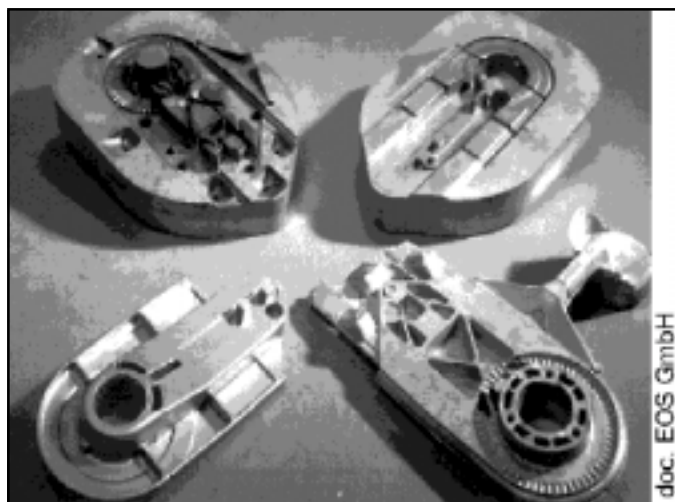


Figure 3: Inserts Produced by Direct Metal Laser Sintering of EOS GmbH

to manufacture spare parts in such a way. This is close, indeed, to the Nature analogy previously suggested. On a small scale, we recently manufactured spares for small obsolete plastic components that were used directly as replacement parts. The tooling supplies a palliative element to retain an acceptable level of performance, while at the same time providing a means to manufacture the definitive repair part. Considering a mission to Mars, the required mass and volume required for both the tooling and raw material might well add an advantage compared to other strategies.

Research Perspectives, Challenges and Conclusions

It is clear that the proposed concept has yet to be proven. To do so, several steps must be taken. The most important one is to determine if the parts produced can be used as replacement elements with no added risks. It seems obvious that a candidate elements list has to be established to assess the impact of using

a lower quality part in a real system. Another problem deals with material that could be used that must be qualified for use in a space environment. A key issue is to validate the required manufacturing process in space. The effects of the gravitational differences must be assessed. Note that the tooling required could well fit into an International Standard Payload Rack being used for the International Space Station, which might lead to a set of experiment proposals. Another interesting aspect is to consider the use of local materials to manufacture the parts. Focusing on Mars missions and the live-off-the-land strategy, it should be possible to go even further in the analogy with Nature. The perspective offered by the concept broadens when considering Martian resources. According to several authors, one can reasonably think of producing ethylene and derived products—that is, plastics—and ceramics and metals. The Martian environment consists of radiation, low pressure, and so on. One can think of using these characteristics for the manufacturing process, thus lowering the needs. Ultimately, one could think of melting the palliative part after use. It would be interesting to test a Martian plastic simulation in producing a palliative part.

As a conclusion, one can review the main ideas behind the proposed concept. Providing the means to perform maintenance during exploration missions, such as a human mission to Mars, is a key issue. It is believed palliative parts can be created on site using rapid prototyping techniques. It is certainly true that such a concept might not be used on early missions. The fact is that building a supply support concept for an exploration mission is basically a mix of strategies. We believe this concept is a reasonable alternative to the carefully selected elements strategy.

For Mars missions, advances in that direction should be considered.

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(Readiness continued from page 23)


The differences between a ready force and an ill-prepared one are the confidence, attitude, decisiveness, and endurance of the people. The costs run deeper than combat survival but consider family stability and retention of experienced troops to propagate the capabilities only achieved after years of training and exercising. Commanders make a difference by the priorities they communicate. This research challenges all who command to take a close look at readiness preparation.

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(Is Agile Logistics—Focused Logistics in Hiding? continued from page 26)

focused mission unfold—one can only imagine filling MICAPS in a space environment? How can reach-back capability be defined then? It cannot be unless there is logistics doctrine to fall back on.

This argument is not fundamentally new. The real question is whether it is an evolutionary movement toward a more focused agile logistics support structure or an effects-based structure needed to meet the requirements of the modern battlefield? Current logistics reengineering efforts would support the latter. For example, the draft version of the Logistics Transformation Plan lists the traits necessary for a successful transformation as "time-definite delivery, time-definite resupply, theater reach back to CONUS logistics centers, and develop for use, an integrated state-of-the-art information system to source, acquire, and transport items directly to the warfighter." Major K. Noedskov wrote an article titled "Systematizing Effect-Based Air Operations" that outlined his proposal to systematize the operational-level, effects-driven planning process. Major Noedskov's outline is used to identify centers of gravity at the strategic and tactical level and assign decisive points and associated effects at each of the three levels of war. However, his framework has been adjusted slightly to present a concept of effects-based logistics.

According to current Air Force doctrine, the tenets of agile logistics are defined as time-definite delivery, reach-back capability logistics command, control, and global combat support system. These four tenets will be identified as logistic centers of gravity. The desired end states will be deploy, sustain, and protect. The defining points will be the operational mission-capable rate and sustainment.

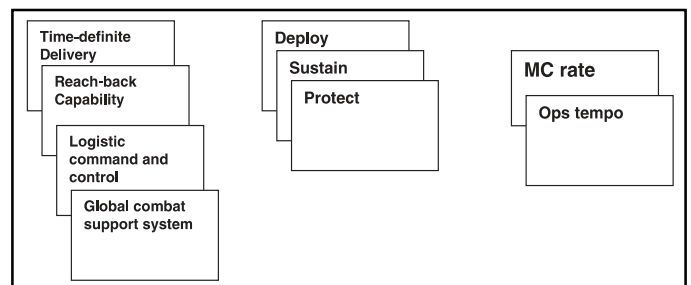



Figure 1. Tenets of Agile Logistics

Using this proposed Four Box Model, the concepts listed above would constitute logistics centers of gravity. The cumulative effects of these four centers of gravity could impact the desired effects of an operation or a deployment. The three desired end states summarize the logistics mission during critical elements of an operation—the requirement to deploy, followed with the need to sustain operations while protecting assets. Each of these areas constitutes critical effects of the entire logistics system, which could impact the operation. Logistics functions should be considered as more than simply enablers to the Air Force mission. As Alexander the Great noted centuries ago, effects-based logistics is key to operational campaign success.

My logisticians are a humorless lot . . . they know if my campaign fails, they are the first ones that I will slay.

—Alexander

Colonel Stinson is chief, Technology Branch, Logistics Management Directorate, Air Education and Training Command, Randolph AFB, Texas. 

Innovative or Insane? Civilian Contract Air Refueling

The article by Major Mark D. Camerer (Volume 26, Number 1) advocates actively pursuing civilian contract air refueling (CCAR) capability to aid in the defense of the nation. The article cites numerous sources and facts and then concludes that the way ahead is *singular*. Unfortunately, the article relies upon errors and omissions of fact in order to make its point.

In March 1998, The US Transportation Command (USTRANSCOM) thoroughly evaluated the CCAR concept and rejected it as providing no significant wartime requirement or cost benefit for the Services. In March 2000, USTRANSCOM forwarded its findings to the Director of the Joint Staff, who independently determined that the potential wartime benefit was not worth the costs. As recently as June 2002, the USTRANSCOM commander, in a letter to the Chief of Naval Operations, stated, “The Navy can save precious dollars through use of AMC [Air Mobility Command] tankers” and “I hope that your staff might reexamine the value of continuing your Omega Air (CCAR) contract.”

USTRANSCOM and the Joint Staff disagree with the CCAR concept because the facts don’t support it. The article implies that the concept has been proven and that it is providing cost saving services to the Navy. This is not the case. The single CCAR aircraft is used to support test and local training operations for probe-equipped aircraft only. The author spends time making a case that CCAR operations are cost-effective, but the data provided obfuscate the truth. The author claims that the cost of flying hours on a CCAR tanker “fits squarely in the middle of organic air-refueling costs.” This could be a point of comparison if the Navy reimbursed the Air Force for air-refueling flying-hour costs—but it doesn’t—the Navy reimburses the Air Force for fuel offloaded, just like it does to the CCAR, but then, the Navy also has to pay the rest of the CCAR bill.

But what is the bill the taxpayers are paying? The article cites a CCAR cost per hour of \$5,995. This number is a half-truth. The Navy is actually paying approximately \$9,000 per hour for the CCAR service and has budgeted \$10,000 per hour—all while Air Force tankers are essentially free to the Navy and Marine Corps as a product of the Air Force training program and operations and maintenance account. The Navy reimburses the Air Force for fuel offload only, while it must pay CCAR for the fuel offloaded, tanker aircraft fuel burn, and per diem, in addition to the \$5,995 per flight hour. In effect, the taxpayers pay twice for every fill-up on the CCAR aircraft: a \$9,000 per hour CCAR bill and the normal training flying hour bill for the Air Force tankers, which the Navy opted not to use.

In making the case for training benefits, the article states, “CCAR increases training opportunities.” This is false. The Department of Defense (DoD) has long held that units should train, as they will fight. Refueling off CCAR aircraft is incomplete air-refueling training for the Navy since the CCAR aircraft is dissimilar from KC-135 and KC-10. Additionally, use of the CCAR by Navy forces denies currency-training opportunities to Air Force crews. This loss of training actually decreases airpower employment effectiveness through loss of currency by aircrews in both Services.

Another claim made by the article is, “CCAR fills the gap in wartime plan deficiencies.” The author omitted mention of a 1996



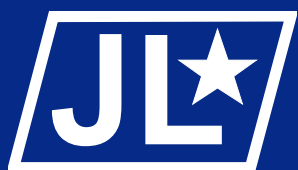
Lieutenant Colonel Robert D. Pollock, USAF
Deputy Chief, Mobility Division
Directorate of Global Reach Programs
Assistant Secretary of the Air Force

DoD report to Congress, which identified what combat missions could be civilianized and what could not. Based on months of study and Office of the Secretary of Defense review, the report states that air refueling was not a candidate for civilianization since it is an inherent combat capability critical for the Navy and Marine Corps and was particularly critical to the Air Force in order to execute the Global Strike and Global Mobility missions. Use of civilian aircraft in war scenarios raises significant unresolved legal and treaty issues far outweighing any benefit to be derived by the civilian tankers.

In July 2002, AMC reviewed the CCAR aircraft against the Joint Requirements Oversight Council-approved mission requirements for air refueling aircraft and found that the CCAR airframe meets none of the nine criteria established for air refueling aircraft. CCAR fails to meet the requirement for refueling the full range of receiver aircraft. It is not capable of carrying and offloading fuel other than primary fuel. It cannot maximize fuel offload rates within receiver onload capabilities. It cannot onload fuel as a receiver from other air-refueling aircraft. CCAR aircraft are neither capable of meeting alert requirements nor capable of operating amidst worldwide threats. They do not have a multimission capacity and are not able to serve as a robust, survivable, and secure communications link. In all, CCAR represents the antithesis of filling “the gap in wartime plan deficiencies.” Planning for the “specialized” use of the CCAR would instead add to the “fog of war” during today’s need for instantaneous response.

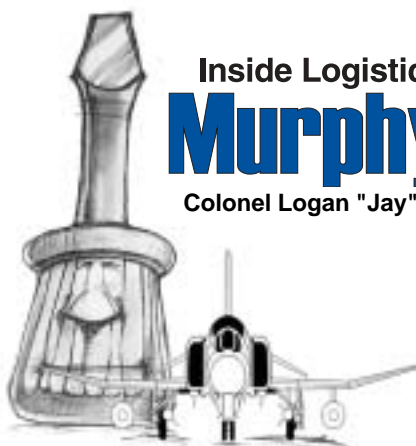
Finally, the article states, “AMC does not have a plan to fill near-term requirements.” This claim is dated at best and truly misleading, given the other reports and citations referenced in the article. Over the last year and a half, AMC, Air Force Materiel Command, the Air Force Studies and Analysis Agency, USTRANSCOM, the Air Staff, and the Joint Staff have been actively pursuing innovative recapitalization options for the tanker fleet. In December 2001, Congress permitted the Air Force to explore an operating lease for up to 100 767-based tanker aircraft in a configuration that would permit refueling of Air Force and Navy/allied aircraft on the same mission. This and other recapitalization options represent reasoned and responsible paths ahead and a near-term solution.

Given the facts, the way ahead for air refueling is indeed “singular”—USTRANSCOM and the Joint Staff have provided it. CCAR meets no significant wartime requirement and provides no cost benefit to the services.



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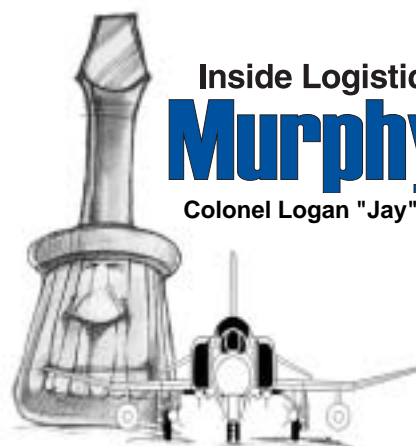


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The Editorial Advisory Board selected "Murphy's Law"—written by Colonel Logan "Jay" Bennett, USAF, Retired, Vol XXV, No 3—as the most significant article to appear in the *Air Force Journal of Logistics* in 2001.

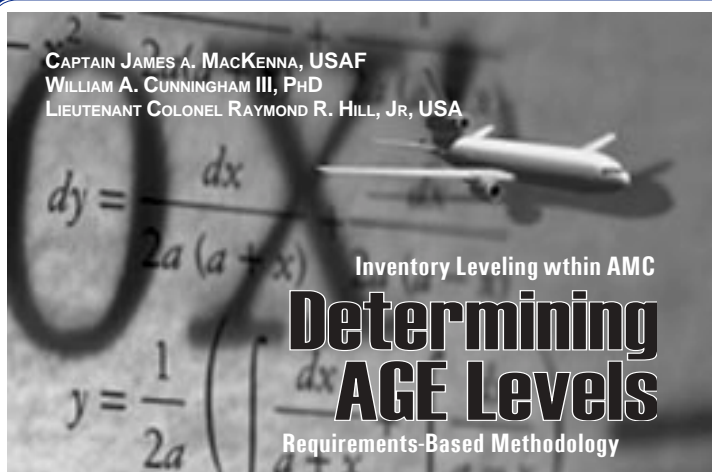


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CAPTAIN JAMES A. MacKENNA, USAF
WILLIAM A. CUNNINGHAM III, PhD
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Inventory Leveling within AMC **Determining AGE Levels** Requirements-Based Methodology

SOLE—The International Society of Logistics, Montgomery, Alabama—selected "Determining AGE Levels"—written by Captain James A. MacKenna, USAF, with William A Cunningham, PhD, and Lieutenant Colonel Raymond R. Hill, Jr, USA, Vol XXV, No 4—as the best article written by a junior officer to appear in the *Air Force Journal of Logistics* in 2001.



EXPLORING THE HEART OF LOGISTICS

Total Mobility Flow: A Post-Kosovo Role for the DIRMObFOR

Colonel Nonie Cabana, USAF

Air mobility played a crucial role by enabling and sustaining the air war that ultimately forced Milosevic to NATO [North Atlantic Treaty Organization] demands.

—Lieutenant General William J. Begert,
USAFE Vice Commander

The Editorial Advisory Board also selected "Total Mobility Flow: A Post-Kosovo Role for the DIRMObFOR"—written by Colonel Nonie Cabana, USAF—as the most significant article to appear in the *Air Force Journal of Logistics*, Vol XXVI, No 1.